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GENERAL VIEW OF THE TWELFTH AUTOMOBILE EXHIBITION AT THE GRAND PALAIS, PARIS

THE TWELFTH PARIS AUTOMOBILE EXHIBITION. GENERAL VIEW ON THE OPENING DAY

THE PARIS AUTOMOBILE SHOW.—[SEE PAGE 24]

Riddles of Science—New Elements in Chemistry

A Popular Talk by Sir William Crookes

By the English Correspondent of the Scientific American

At a recent dinner of the Authors Club of Great Britain, Prof. Sir William Crookes, F.R.S., the eminent chemist, gave an interesting popular address on "New Elements in Chemistry." In the length of his discourse he traversed some of his own remarkable contributions to our knowledge of physics and chemistry, and how such have influenced the modern trend of scientific investigation. He pleaded guilty to much speculation on the nature of those complex variable and elusive mysteries that science has been accustomed to call "elements."

Before the eighteenth century, he remarked, the idea of elements was not much removed from the earth, air, fire, and water of Empedocles—termed as the rational units, and he proceeded to show that the ancients in their crude classification were not so remotely removed from the actual truth as appeared at first sight. In the eighteenth century, when modern conceptions of chemistry first dawned on the scientific mind, the credulous chemist accepted the elements as ultimate facts. In the nineteenth century scientific men gravely doubted, and asked for proof of what hitherto had been taken for granted. Obvious explanations, he pointed out, were seldom the true ones, for simplicity was not a characteristic of Nature. For nearly a century men of science had been dreaming of atoms, molecules, ultramundane particles, and speculating as to the origin of matter. This dream had been essentially a British dream, and toward the end of the nineteenth century the notion of impenetrable mysteries was dismissed. To-day we were confronted by problems and speculations concerning the ultimate constitution of the bodies we named "elements."

In 1879 he advanced a theory, which has now been accepted, that in the phenomena of the electric cathode stream we were dealing neither with solid, liquid, nor gaseous particles, but with matter in a fourth state—"radiant matter" he called it then—which Sir Oliver Lodge described as "something much smaller than the atom, fragments of matter, ultra-atomic corpuscles, minute things, very much smaller, very much lighter than atoms—things which appeared to be the foundation stones of which atoms are composed." Johnstone Stoney, nearly twenty years later, showed that a definite charge of electricity was associated with the ions of matter, and this charge he called an electron. It was later still that electrons were found to be the same as radiant matter, capable of existing independently. The identity of matter with electrons threw all our notions of what constitutes a chemical element into temporary confusion. Chemists began to ask themselves, "What is the actual ultimate element?" The very idea of an element as something absolutely primary and ultimate was growing less and less distinct, until to-day we admitted the possibility of resolving the chemical elements into simple forms of matter, or even of refining them away altogether. In 1886 he ventured to revive the speculation that behind and anterior to matter was a substance (sub stans) which he called "protyle." By the operation of forms of energy on protyle he drew a picture of the gradual formation of the chemical elements; those of lower atomic weight forming first, then those of intermediate weight, and finally the elements of highest atomic weight, such as uranium. "What comes after uranium?" he asked, and he answered back, "The result of the next step will be the formation of bodies the dissociation of which is not beyond the powers of our terrestrial resources." This was little more than a dream twenty-five years ago, but a dream which daily drew nearer to entire and vivid fulfillment. Now in the twentieth century, ideas were floated which lead us to think the old views of Empedocles might not be so hopelessly absurd as they were considered some years ago. Regarded as elementary attributes all Nature was included in the ideas of "earth, water, air, and fire." The conception of solidity was embodied in the word "earth"; water stood for the state of liquidity; air represented the gaseous condition, while "fire" stood for all forms of preponderable energy. Opinions differed as to the constitution of the electron. Some consider it to be an electrical charge on a material substratum; others saw no necessity for the material nucleus, and considered the electron to be pure disembodied electricity, thus approaching to the old idea of Buscovitch, accepted by Faraday, that the atom was only a center of force.

But if we were dubious as to the constitution of the electron, physicists had settled many of its physical constants. Taking as a standard the atom of hydrogen, the smallest material body hitherto recognized, the mass of the electron was 1/7000 of an atom of hydrogen, and it moved with a velocity of two-thirds that of light. It was easy to see that its kinetic energy was enormous, equal to 3,500,000 foot-tons per milligram. So far he had given speculations with no apparent connection. Chemists had been battering at the door of the unknown, doing their utmost to get a glimpse of a few of the secrets so darkly hidden. Suddenly an unexpected, almost incredible thing happened: radium, the epoch-maker, was discovered, and then speculations which were drifting in chaos began to show some signs of order. Radium, judged by severest chemical canons, had all the attributes of a chemical element. It formed salts with the halogens, it had a definite atomic weight, it had a well-defined characteristic spectrum, and it had the appearance and luster of a metal. A bit of radium that would go into a thimble had almost shaken our belief in the conservation of substance, the stability of the chemical elements, the undulatory theory of light, and the nature of electricity. Radiant matter and radium had given us a new science—that of radio-activity. Not only had radio-activity revealed to us the fact that the "element" radium was changing into helium, but chemists alert to the strange metamorphosis had traced similar changes in other directions. Derived elements were revealing themselves with bewildering rapidity, more than twenty being known—and the cry was "still they come."

It was in the ores of uranium that radium was first discovered, and for some time they were considered to be only accidental associates; later work had shown them to be interchangeable. Uranium itself was undergoing slow change, passing through one or more intermediate forms into radium. He likened uranium and the new bodies proceeding therefrom to a genealogical tree. There were more than twenty of these new bodies, all of which deserved the appellation of elements. But whereas the elements of the nineteenth century were apparently everlasting, these upstart elements had finite existences. Uranium for instance has a life duration of 300,000,000 years, radium one of a few thousand years, others of a few days, and so on, till we came to those whose life history was rounded by four seconds. Nature supplies us with facts which were riddles until the law of change was recognized. One body in its mineral ore was almost always associated with another body; sometimes in small, and at other times in larger, quantities. Let no one, however, contemplate wealth beyond the dreams of avarice by laying down a cellar full of lead and waiting for it to mature into silver and gold. Probably the expected transmutation would occur, but its completion would require a lapse of time compared to which the 300,000,000 years' life of uranium would be a trifle.

Physicists were now beginning to say that there was no such thing as matter; that when we had caught and tamed the elusive atom and split it into 700 little bits, these residual little particles would turn out to be nothing more than superposed layers of positive and negative electricity. He refrained from speculating as to what would happen if some clever researcher of the future discovered a method of making these alternate layers of plus and minus cancel each other out!

It must never be forgotten that theories were more than mutable; they were only useful so long as they admitted of the harmonious correlation of facts into a reasonable system. Directly a fact refused to be pigeon-holed, and would not be explained on theoretic grounds, the theory must go or it must be revised to admit the new fact. The nineteenth century saw the birth of new views of atoms, electricity, and ether. Our twentieth century views of the constitution of matter might appear satisfactory to us, but how would it be at the close of the present century? Were we not incessantly learning the lesson that our researches had only a provisional value. A hundred years hence should we acquiesce in the resolution of the material universe into a swarm of rushing electrons? He could not conclude better than by quoting some words he wrote more than thirty years ago: "We have actually touched the borderland where matter and energy seem to merge into one another—the shadowy realm between the known and the unknown. I venture to think that the greatest scientific problems of the future will find their solution in this borderland and even beyond. Here it seems to me lie ultimate realities, subtle, far-reaching, wonderful."

Real Wild Horses

It was the Russian explorer, Prjevalsky, who discovered a new and quite distinct wild horse in the Gobi Desert, to the south of Mongolia. Although evidence existed that wild horses were probably as abundant in prehistoric times in the south of Europe as zebras are to-day in British East Africa, most naturalists believed that true wild horses with an unbroken line of wild ancestry were extinct. Hence great interest was felt in Prjevalsky's discovery. Later the brothers Grum-Grjimailo saw the horses in the desert and learned new facts about them.

The Russians decided to capture a number of the animals and take them to Europe. Their efforts were successful, and several years ago a herd of about thirty of the Prjevalsky horses, after much trouble, were landed in Europe. Most of them are still in Russia, but a few were taken to England, where they are kept on the estate of the Duke of Bedford.

The English naturalists did not make a scientific study of the animals in that country because the Russians have had a most thorough investigation in progress, with the advantage that nearly all the captive horses and a number of skeletons are in their hands. Very few of the English naturalists believed that they were true wild horses, but looked upon them either as a klang, hybrid—the kiang being a species of ass—or as the offspring of escaped Mongol ponies.

The Russians, however, appeared to have settled the question. They have proved, it is claimed, by the methods of comparative anatomy and in other ways that the Prjevalsky horse has no relationship with Mongol species or the kiang, but is a valid and distinct species of the genus horse, without relationship to the ass, although it has some features that remind one of the Asiatic ass; but even in these features, as the tail, for example, the resemblance is closer to the horse than to the ass.

The animals were mere colts when they arrived in Europe, and were not prepossessing, for they did not take kindly to the novel surroundings, were out of condition, and had ragged coats and awkward gaits. They have now reached maturity, have been well cared for, and are good-looking animals.

Many naturalists hold the opinion that the domestic horse of to-day was mainly derived from three wild species, which have been named the steppe, forest and plateau varieties. The Prjevalsky horse is a representative of the steppe variety.

The brothers Grum-Grjimailo, who have had the best opportunity to observe this horse in its wild state, say that it lives in the level districts and goes at night to the pasture-lands and drinking-places. At break of day it returns to the desert, where it rests until sunset.

When there are nursing colts in the herd the animals always rest in the same place, but this does not appear to be the case when the foals become larger.

They usually walk one behind the other, so that the region where they live is covered with deep tracks. They neigh clearly, and the sound is exactly like the neigh of the domestic horse. There is the same resemblance between the snorting of a badly frightened wild horse and that of domestic horses when scared.

The Mongolians have made many attempts to tame the wild horses, but in vain. All efforts to tame the animals that have been taken to Europe have also failed. Thus far the horse will not submit to man, is afraid of him, and cannot be rendered serviceable. Although now accustomed to the sight of human beings, the captives are very badly frightened if a person approaches nearer than two or three rods of them.

Recently the use of iron wire instead of platinum in the manufacture of electric light bulbs was forecasted by Dr. H. J. S. Sand, of the Nottingham University College. Dr. Sand gave a demonstration of vacuum-tight seals between iron and glass. He announced his discovery of a method of sealing iron wire vacuum-tight in glass. Till now, he said, the only metal that had been sealed vacuum-tight into glass on a successful commercial scale was platinum. Two hundred and fifty million electric lamps were manufactured annually, and they contained minute pieces of platinum wire. Platinum was one of the most expensive metals known, and the amount used annually in this way was worth over $500,000. The cost of the same wire, if of iron, would be practically negligible.

The Number of Stars in the Universe

How Celestial Bodies Are Counted

By Otto Hoffmann

ONE of my favorite books is Prof. Newcomb's little volume entitled "The Stars," from which I have often derived both instruction and inspiration. When this book was published, a few years ago, certain views expressed in it created a mild sensation. These views, according to which the stellar universe is limited in space and composed of a finite number of stars, have since crystallized into a theory of great probability.

It was always foolish, indeed, to assume the existence of an infinite number of stars. The only ground for this assumption is the apparently infinite number of stars visible even with the naked eye. Yet the number of such stars is surprisingly small. The "Almagest," attributed to Ptolemy, which was really written by the Greek physician Hipparchus, enumerates about 1,000 stars, and approximately the same number is given in the catalogues compiled by the Arabian Al Sufi and by Ulugh Beigh, a grandson of the famous conqueror Tamerlane. These old catalogues, however, include only bright and conspicuous stars. It is certain that a much larger number was visible to the ancient observers. About 2,000 stars can be seen above the horizon at one time on a clear night by the average eye. According to Backhouse, more than 25,000 stars would be visible to the naked eye if there were no atmosphere. The German astronomer Heis, who possessed uncommonly keen sight, published in 1872 an atlas which contained 4,943 stars visible between the north pole of the heavens and the 20th degree of south latitude. This work was supplemented in 1874 by Behrmann's atlas, containing 2,306 southern stars. The sum of these two numbers, 7,249, represents the whole number of stars that can be seen by unusually good eyes.

The number of stars revealed by the telescope is enormously greater than this. The most extensive star catalogue which we possess is the work of the indefatigable Argelander, of Bonn, who in the middle of the 19th century indicated the places of all known stars, down to magnitude 9.5, situated between the north pole and the second degree of south latitude, 324,189 stars in all. Argelander's work has been extended southward by his successors Schoenfeld, at Bonn, and by Gould and Thome, at Cordoba, Argentina, and is not yet quite finished. The complete catalogue will give the places of about 800,000 stars, as stars of the 10th magnitude are included in the Cordoba observations.

All of these numbers, however, are very much smaller than the total number of stars actually in existence. Sir John Herschel estimated that 5½ million stars could be seen with his 20-foot telescope. Struve estimated the whole number of stars at 20 million. Pickering thinks that more than 50 million stars can be seen with the great refracting telescope of the Lick Observatory, which shows stars of the 16th magnitude.

Still fainter stars can be photographed with long exposures. Dr. Roberts's photographs of the sky show about 64 million stars, according to Core's estimate. The Carte du Ciel, the international photographic atlas of the heavens, the production of which was decided upon at a congress which met in Paris in 1900, is expected to show 13 million stars, although it will not include any stars smaller than the 14th magnitude. The whole number of stars in our stellar system is several hundred millions, according to Newcomb, and a thousand millions, according to Dyson.

That the stars cannot be infinite in number is evident from the following considerations. The fainter stars, taken together, emit more light than the brighter stars. Hence, if the number of stars were infinitely great, the whole sky would appear as bright as the noonday sun. In reality the background of the sky is quite dark, and the total amount of light which we receive from the stars is very much smaller than that which the sun sends to the earth. Prof. Newcomb concluded, in 1901, that the total starlight is only 728 times the light received from the star Capella, or 1/89 the light of the full moon.

These statements will be made more intelligible by an inspection of the following table, containing the number of stars of each stellar magnitude:

Magnitude.	Number of stars.
Between 1st and 2nd	39
Between 2nd and 3rd	105
Between 3rd and 4th	300
Between 4th and 5th	1,016
Between 5th and 6th	3,265
Between 6th and 7th	10,200
Between 7th and 8th	31,000
Between 8th and 9th	93,000
Between 9th and 10th	271,000
Between 10th and 11th	710,000

This table shows that the number of stars of each magnitude is about three times that of the preceding magnitude. By continuing to apply this ratio we obtain more than 1,500 million stars between the 17th and 18th magnitudes. But the light of a star of a given magnitude is not 3 times, but only 2½ times, greater than that of a star of the next following magnitude. Hence the light received from all stars of the 9th magnitude, for example, is considerably greater than the light received from all stars of the 8th magnitude. If the universe contained an infinite number of stars distributed among smaller magnitudes even approximately according to these laws, the amount of light, and of heat, received from all the stars would evidently be infinitely great or at least insupportable.

Struve, impressed by this difficulty many years ago, assumed that the light of the stars is weakened by absorption in interstellar space. The value which Struve assigned to this absorption must be regarded as arbitrary, and for a long time it was impossible to decide whether any such absorption occurs. The recent researches of Kapteyn, Nordmann and Tikkoff prove that starlight is slightly absorbed in its flight through space, but the amount appears far too small to create a new basis for the assumption that the number of stars is infinitely great.—Prometheus.

New Discoveries at Knossos

The Remarkable Revelations of Dr. Evans

By H. R. Hall

A LETTER has recently appeared from Dr. Arthur Evans, describing the results of his excavation this year at Knossos. There were many more things that we wanted to know about Knossos, and one of them has been made clear by the work of this season. The great domed pit, the *tholos*, as it seemed to be, over which part of the southern quarter of the palace was built, has been excavated to the bottom, not without danger to the workmen. And it turns out to be a great *tholos*-like reservoir, with a spiral staircase round the inside of it, which breaks off, as in other similar cases, at what must have been the average water-level. The springs that supplied this reservoir are now dry, and no doubt were so before the place was entirely filled up. This was done, as we know from the character of the potsherds found in it, in the first "Middle Minoan" age.

"In other words, the reservoir itself belonged to the Early Minoan Age, and was filled in at the time of the construction of the first palace of which we have any existing remains—the object of the work being to obtain a secure foundation for the South Porch and adjoining parts of the outer wall. The filling materials themselves were probably supplied by the leveling away at this time of the summit of the 'Tell' of Knossos in order to gain the area for the central court of the palace." There was also a smaller reservoir on another part of the mound, "and from the magnitude of the work we may well conclude that some earlier predecessor of the great palace already existed on the site that it has since occupied."

This is an important conclusion. If we are to judge by the reservoir, the early Minoan palace was probably a great architectural work. The "Early Minoan III." architects were perhaps almost as capable as their contemporaries, the Egyptian pyramid-builders of the fifth and sixth dynasties.

In the small "palace" on the hillside west of Knossos further discoveries have been made, including a paved way with the rut-marks of ancient Minoan chariots. In this part of the site more recent remains, of classical and Roman date, constantly are found above the Minoan level; whereas in the main palace, "whether owing to a superstitious awe or to other causes, the hilltop . . . was never invaded by later habitations." A fine metope of a Doric temple, contemporary with the Parthenon sculptures, was found over the western palace.

Mr. Doll has proceeded with the work of conserving the palace buildings, and has run the great staircase another flight higher. Also the nature and composition of the frescoes have been studied by Mr. Noel Heaton.

In the tomb-field of Isopata further important discoveries have been made, owing to the *flair* of Gregori, Dr. Evans's Cypriote foreman, "the most expert tomb-hunter of the Levant. . . . The wild, long-rooted fennel, which seeks out by preference the spots above ancient cuttings, served him, as often before, as a guide, and the result was the discovery of six chamber-tombs, some of which for their size and the interest attaching to their contents and arrangement surpass any hitherto known of this class."

The date of the tombs is the second late Minoan period, about 1450 B. C., contemporary with the eighteenth dynasty of Egypt. The most remarkable point about these tombs is the information as to Minoan religion which they give us. In one tomb, where "the religious interest culminated," was found an arrangement wholly new, which "rather recalled the domestic Etruscan ideas of the after-life than anything yet known of the Minoan age." The tomb was made to resemble a house of the living, with stone-cut benches, as if for family gatherings. And at the head of the sepulchral cist were found the remains of a double-ax shrine, with an offering-vessel, in the shape of a bull's head, lying close by. These tomb-chambers seem not to have been kept open regularly, but were opened for solemn service on the anniversary of the death probably. They were rifled of their more valuable contents by robbers of the early Iron Age (geometrical period), who left behind traces by which we can identify their date.

"It will be seen that the 'Tomb of the Double Axes' has produced more definite evidence regarding the sepulchral cult and religious ideas as to the after-world than any grave yet opened in Crete or prehistoric Greece."

Dr. Evans's comparison of the interior of the tomb with that of an Etruscan grave is very apposite and suggestive. This Etruscan impression has already been given by the great painted sarcophagus found by the Italians at Agia Triada, and it is most interesting to see how a relationship between the Etruscan, Minoan, and Anatolian (Hittite) cultures in matters of religious cult is gradually becoming clearer to us.—Nature.

Waterproof wall paintings on a finished background of mortar made from lime, quartz sand, infusorial earth and water are prepared as follows: Painting ground: Four parts of quartz sand, 3.5 parts marble sand, 0.5 part infusorial earth heated to redness, 1.5 parts thick lime paste. After drying, the painting ground is to be coated with hydrofluosilicic acid and impregnated, several times with potash water-glass; earth colors which have been digested for a long time with potash water-glass are used. After dilution the silicic acid is separated by means of carbonate of ammonia from the water-glass, which remains in intimate combination with the colors. To the washed-out colors, hydrate of alumina and hydrate of magnesia are added; they are rubbed down and preserved in paste-like condition. The pictures are fixed by means of a spraying apparatus and a fluid obtained by heating 200 parts of potash water-glass, 100 parts caustic ammonia, 10 parts caustic potash, and 12 parts marble powder, and decanting this from the residue. After fixation, which must be done four to five times, at a temperature of 100 deg. to 120 deg. F., the painting must be washed with carbonate of ammonia, then with water, and finally impregnated with a solution of paraffine in petroleum ether.

Automatic Stabilizing System of the Wright Brothers

An Interesting Control System Devised by the American Inventors

It is well known that the control of the Wright aeroplane makes great demands on the attentiveness and skill of the pilot, and that long practice is required in order to learn the art of steering. The steering of a Farman, Sommer or Voisin biplane can certainly be mastered in a shorter time, and this may be the reason why more pilots are to be found for machines of these types. In order to facilitate the guiding of their biplane, the Wright brothers have devised an automatic stabilizing system. The following description of this system is derived from the British patent 2,913 of the year 1909 and the French patent 401,905:

A flying machine is in equilibrium when the resultant of all air pressures is vertical and passes through the center of gravity. The position of this resultant, however, is dependent upon the angle which the sustaining planes make with the apparent direction of the air current, which is, in general, opposite to

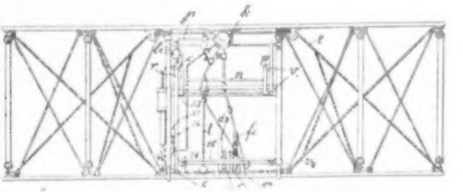


Fig. 1.—Front elevation of the Wright biplane with automatic stabilizing system.

the direction of flight. Any change in this angle alters both the magnitude of the resultant force and its position relatively to the center of gravity. These changes in the resultant affect the angle of incidence, in turn, and so the disturbing factors rapidly augment each other and the machine soon capsizes, unless the disturbance is checked at its first manifestation by proper manipulation of the elevating and steering rudders and by warping the sustaining planes.

Two devices, almost identical in principle and in construction, have been adopted by the Wrights for the purpose of assuring an immediate and automatic restoration of the angle of incidence to the value which held the aeroplane in equilibrium on its definite course, before the disturbance occurred. In one of these devices the elevating rudder is operated by an auxiliary plane whenever the aeroplane pitches or turns about its transverse horizontal axis, while the other device, which includes a pendulum, operates the vertical rudder and warps the sustaining planes whenever the machine rolls, or turns about its longitudinal horizontal axis. No special mechanism is provided or required for insuring stability with respect to the vertical axis, because the torque about this axis which is produced by the warping of the sustaining planes is compensated by the association of lateral steering with the warping. Zigzag flight, if it is not entirely prevented by the vertical stabilizing planes of the newer Wright biplanes, can easily be checked by hand steering, before it becomes a source of danger.

The mechanism employed for the prevention of pitching is connected with the horizontal or elevating

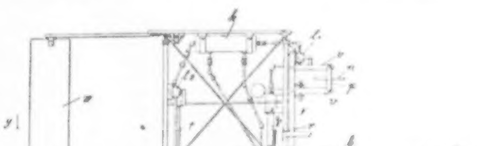


Fig. 2.—Side elevation of Wright biplane with stabilizing system.

rudder. This rudder, a (Fig. 2), is placed in front of the sustaining planes, and a grooved wheel on its shaft is connected by a cord b with another grooved wheel c_1 (Fig. 3) which can be turned by the hand lever d^1. The shaft of the wheel c^1 carries a loose wheel e_1, which can be disconnected from c_1 by pressing the spring f^1. When the two wheels are connected the rudder is operated automatically by means of the mechanism now to be described. The wheel e_1 is connected permanently by the rod g_1 with the differential piston shown in Fig. 4. The lower cylinder i, in which the small head of this piston moves, communicates permanently with a reservoir of compressed air by means of the inlet j_2, so that the piston is always subjected to pressure from below. The upper and larger cylinder h can be put in communication with the reservoir by means of the inlet j_1 and the three-way cock shown in Fig. 5, which can also be adjusted to put the cylinder h in communication with the atmosphere, or to isolate it completely and thus to stop the piston. These connections are made possible by the arrangement of the channels of the three-

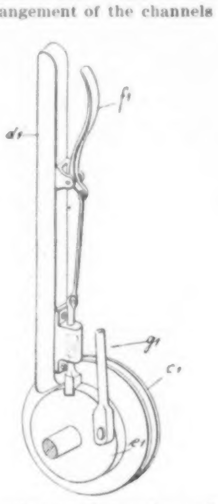


Fig. 3.—Handle of elevating rudder.

way cock, as will appear on inspection of Fig. 5. The three-way cock is turned by the movements of an auxiliary plane, the arrangement and the operation of which are illustrated by Fig. 6. The auxiliary plane n is attached to the vertical arm p. The ends of this arm are connected by hinges to the outer ends of two equal and parallel arms rr, whose inner ends are similarly connected to the rod r. The weight of the plane and the arms is balanced by a counterpoise attached to an extension of the lower arm r. The vertical movement of the plane is limited by the stops q. When the plane is depressed to its lowest position, indicated by the dotted lines in Fig. 6, by air pressure from above, it turns the three-way cock l, into such a position that the large differential cylinder h is put in communication with the outer air through the channels m_1 and m_2 (Fig. 5). The piston (Fig. 4) is consequently forced upward by the excess of pressure in the lower cylinder i (which communicates permanently with the compressed air reservoir). As the piston rises it draws upward the connecting rod g_1 (Fig. 3) and thus turns the wheels e^1 and c_1 and, by means of the cord b, (Fig. 2) gives the elevating rudder a an inclination which causes it to lift the bow

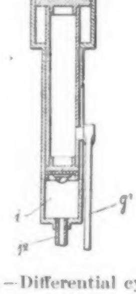


Fig. 4.—Differential cylinder.

of the aeroplane. The opposite effect, depression of the bow, is produced automatically whenever the auxiliary plane n (Fig. 6) is forced upward by air pressure from beneath, so that it turns the three-way cock to a position in which the tubes j_1 and j_2, leading respectively to the compressed air reservoir and to the upper differential cylinder, are connected by means of the channels m_1 and m_2 (Fig. 5). The piston is then forced down in consequence of the inequality in area of its two heads.

Let us now see in what conditions the auxiliary plane is impelled to produce these results. The auxiliary plane is inclined to the principal sustaining planes at an angle which the inventors call the critical angle of incidence and which is equal to the angle between the sustaining planes and the apparent air current or relative direction of motion. Hence, when the aeroplane is moving forward without disturbance the relative air current is parallel to the auxiliary plane which consequently remains at rest in its neutral or middle position. If, however, the inclination between the sustaining planes and the relative air current becomes less than the critical angle, and the machine tends to fall, in consequence of the diminution of the vertical component of the air resistance, the auxiliary plane is forced down, causing the differential piston to rise and turn the elevating rudder upward. If the three-way cock and the arms which carry the auxiliary plane were attached directly to the frame of the machine the critical angle of incidence would be invariable and an arbitrary and a uniform elevation or depression would be produced by the device. The arms and the three-way cock, however, are attached to the rod r (Fig. 6) which is suspended from the frame by a hinge at s. The magnitude of the critical angle is determined by the position of this rod relatively to the frame and sustaining planes, and this position can be varied by means of an adjustable clamp at y. In ascending, for example, the rod r is swung backward in accordance with the increased

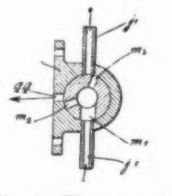


Fig. 5.—Three-way cock.

angle at which the relative air current strikes the sustaining planes, and the angle of ascent is maintained constant by the automatic operation of the auxiliary plane and its accessories, as long as the rod r remains clamped in this position. The practical efficiency of the device, especially in variable winds, can be demonstrated only by experiments of which no account has yet been published, to the writer's knowledge. The inventors admit that the disturbing influences are not exactly compensated, but that the auxiliary plane and the elevating rudder are first moved too far and oscillate before they settle down into their new positions. In the writer's opinion, periodical gusts of wind might do more damage with this device than without it.

A simpler form of the apparatus is shown in Fig. 7. Here the auxiliary plane n is attached directly by a hinge to the frame of the machine, while an additional positive or negative angular displacement can be given to the three-way cock l, by means of the lever r.

The apparatus employed by the Wright brothers for the purpose of assuring stability with respect to the longitudinal axis is very similar to the device described above. It includes a differential cylinder with its smaller chamber in permanent communication with the compressed air reservoir, with which the

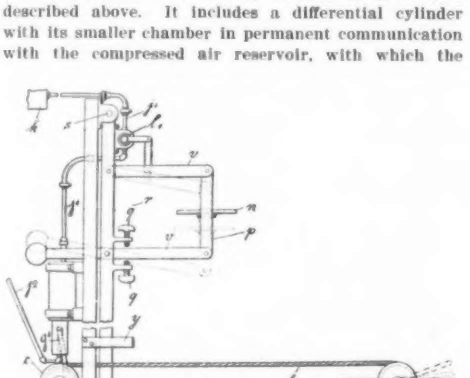


Fig. 6.—Side elevation of fore and aft stabilizing mechanism with auxiliary plane.

larger chamber can be connected by means of a three-way cock. Here, however, the three-way cock l_2 (Fig. 8) is operated by a pendulum t. The manner in which the warping of the sustaining planes and the turning of the vertical rudder are automatically produced is illustrated by Figs. 9 and 10. The hand steering lever d_2 (Fig. 9) is attached to a grooved wheel c_2, mounted on the lower sustaining plane to the left of the pilot, which is connected with the loose wheel e^2 except when the bolt u (Fig. 10) is drawn back by pressing the spring f_2. The loose wheel e_2 is permanently connected, by the rod g_2, with the differential piston, while the grooved wheel c_2 is connected by the cord v_1 with the warping cord v_2, which runs to the tips of the sustaining planes. The vertical rudder x is connected by the cord v_3 with another grooved wheel c_3, which can be connected with the shaft by the friction clutch n and which is also provided with a hand lever d_3.

If the aeroplane rolls so as to raise one end of the sustaining planes, as in Fig. 8, the pendulum t swings to the opposite side and turns the three-way cock l_2 so as to produce an excess of pressure in one chamber of the differential cylinder, causing the piston and its connecting rod g_2 to move either forward or backward. The result is that the warping cord v_2 is pulled to right or to left by the cord v_1, twisting the tips of the sustaining planes, and that the vertical rudder is simultaneously turned by the cord v_3 to an extent sufficient to counterbalance the horizontal torque produced by the warping of the planes. In this case,

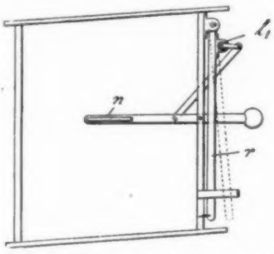


Fig. 7.- Simplified arrangement of auxiliary plane.

also, the disturbing influence is not counteracted exactly and instantaneously, but the pendulum and the rudder perform a number of oscillations before they come to rest in their positions of equilibrium.

In beginning a curved flight the friction clutch is loosened and the rudder is turned by hand, independently of the warping of the planes. If the friction clutch is then tightened, with the rudder in an inclined position, the machine will continue to fly in a curve and the automatic mechanism will act as efficiently as it does in pursuing a straight course.

It has already been remarked that no experiments made with these stabilizing devices appear to have been published. Is this because the Wrights are overwhelmed with orders or because the expectations founded on these devices have been disappointed? If the devices had proved their practical efficiency it would certainly be to the interest of the Wrights to exploit an invention which was announced in the United States in the beginning of the year 1908.

In the writer's opinion the influence of the pendulum must be eliminated in curved flight, as otherwise the warping effected by hand, which depresses the side nearest the center of curvature of the path, would be counterbalanced by the action of the pendulum swinging outward in obedience to centrifugal force. The loosening of the friction clutch at a moment when the attention of the pilot is fully occupied is a serious defect of the pendulum apparatus.

The Manufacture of Hydrogen

THERE has been a large increase in the manufacture of hydrogen within recent years due principally to three causes—(1) the construction of dirigible balloons; (2) its use in the manufacture of tungsten filaments for electric lamps, and (3) the oxyhydrogen blow-pipe flame. The demand for the gas in connection with dirigible airships and the manufacture of lamp filaments seems likely to increase very largely in the near future, and it is therefore opportune at the

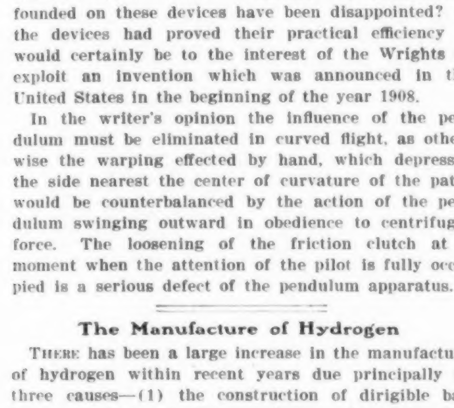


Fig. 8.—Front elevation of transverse stabilizing mechanism with pendulum.

present time to examine the present sources of supply and the methods of manufacture employed.

Hydrogen, which is about 14.39 times as light as atmospheric air, has a much greater lifting power for aeronautical purposes than coal gas, although in point of cost the latter compares favorably. The chief drawback to the use of hydrogen for inflating balloons is its high rate of diffusion, which is 3.83 if the rate of diffusion of air be taken as unity. Although this drawback is being minimized by improvements in the manufacture of balloon fabrics, it is highly important for the maintenance of large dirigible balloons to be assured of a regular supply of pure hydrogen gas.

The manufacturer of tungsten filaments for metallic filament lamps requires a regular supply of hydrogen to prepare the inert atmosphere in which the filaments are heated to a high temperature during the final treatment. There is some doubt whether the hydrogen is really inert in this operation, and in those cases where a carbonaceous binding material is employed the hydrogen probably assists in the complete removal of the carbon, it having been shown that carbon unites slowly with hydrogen to form methane at a temperature of about 1,000 deg. C. (1,832 deg. F.). However this may be, it is the almost universal custom to employ a mixture containing approximately equal proportions of hydrogen and of nitrogen when the filaments are heated to a white heat by the passage through them of an electric current during the sintering operation. Since tungsten filaments when heated to incandescence are extremely sensitive to oxidation, it is of great importance that the hydrogen employed should be of a high degree of purity.

For the autogenous welding of metals, the working of platinum, and the manufacture of laboratory utensils and mercury vapor lamps from fused quartz, hydrogen in the form of the oxyhydrogen blow-pipe flame is used in large quantities, although here it has to meet the competition of acetylene, a gas which is cheaper and readily obtainable as required from calcium carbide.

The preparation of hydrogen by the action of dilute sulphuric acid upon metallic zinc, like most of the other methods usually employed in the laboratory for

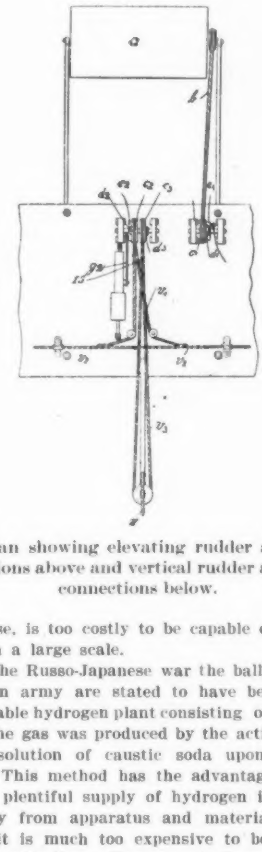


Fig. 9.—Plan showing elevating rudder and its connections above and vertical rudder and its connections below.

this purpose, is too costly to be capable of being carried out on a large scale.

During the Russo-Japanese war the balloon corps of the Russian army are stated to have been equipped with a portable hydrogen plant consisting of generators in which the gas was produced by the action of a concentrated solution of caustic soda upon aluminium shavings. This method has the advantage of readily yielding a plentiful supply of hydrogen in a state of high purity from apparatus and materials of small bulk, but it is much too expensive to be capable of extensive application. Experiments have been made at Bitterfeld in Germany with a compound, calcium hydride, prepared by passing hydrogen gas into molten calcium metal. This substance is very similar in its behavior to calcium carbide, and on treatment with water spontaneously gives off hydrogen in the same way as the carbide yields acetylene. Little is known concerning its cost of production, but if it could be produced on a commercial basis it would obviously possess great advantages, as it would overcome the necessity of transporting the gas in compressed form in steel cylinders. Frank, of Berlin, has patented a method of producing hydrogen by passing water gas over heated calcium carbide. This absorbs nitrogen at a temperature of 300 deg. C. (572 deg. F.), and by removing oxides of carbon with suitable reagents hydrogen gas suitable for inflating balloons can be obtained.

These processes are interesting from a theoretical point of view, and are merely instances of the large amount of experimental work which has been carried out with a view to providing hydrogen for commercial use on a large scale. At the present time most of the hydrogen used for inflating the gas bags of dirigible airships is produced either electrolytically or by the action of steam on red hot iron turnings.

The electrolytic process has been developed to a considerable extent in Germany, and is an application on a large scale of the well-known decomposition of water into hydrogen and oxygen by means of an electric current. It depends for its success upon a cheap supply of electric energy, and as for every two volumes of hydrogen there is simultaneously produced one volume of oxygen, this is also a source of profit. The plant requires comparatively little attention, and the hydrogen may be generated in a condition of great purity.

The other method has been developed in this country by Howard Lane. In this process steam is passed over red hot iron, whereby hydrogen is produced and the metal converted into oxide. The oxide formed, however, can be reduced again to metallic iron by passing water gas, coal gas, and other gaseous fuel into the

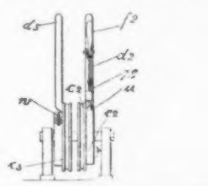


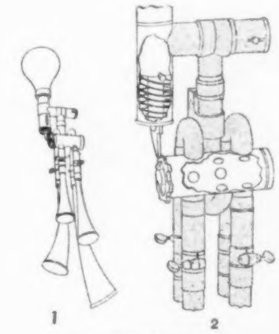
Fig. 10.—Wheels and levers for controlling vertical rudder and warping sustaining planes.

retorts. By employing a number of retorts, some of which are producing hydrogen while in others the oxide is being reduced, it is possible to arrange for a more or less continuous supply of gas. Lane's process has found favor with manufacturers of tungsten lamps because it is also possible to arrange the plant so that when the oxide is being revivified nitrogen can be collected, it being customary for the lamp filament makers to employ a mixture of hydrogen and of nitrogen.

The various methods of producing hydrogen on a large scale have occupied the attention of the war departments of several governments as well as that of the aeronautical societies, and the great progress which is now being made with dirigibles is bound to act as a stimulus to greater activity among chemists and engineers engaged on this problem. There is undoubtedly much to be done before aeronauts can be sure of the immediate delivery of hydrogen in sufficient quantities to meet their requirements.—London Times.

The Testophone

THE testophone is a new automobile horn, so contrived that the monotonous repetition of the same sound is avoided. A blast of air, forced into a pump barrel by compressing an India rubber bulb, moves a piston, the rod of which carries a pawl that engages with a ratchet wheel of eight teeth, attached to the end of a horizontal cylinder, which is capable of rotation inside a fixed cylindrical jacket. The cylinder is thus turned through one-eighth of a revolution each time the bulb is compressed. An air-pipe connects the middle of the pump barrel with the middle of the jacket of the rotating cylinder, and the jacket communicates also with four horns of different pitches, by means of four outlets distributed above and below its axis and to the right and left of its median plane. The rotating cylinder is pierced by eight equidistant orifices in its median plane and by two apertures in each of the planes in which the jacket communicates



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THE TESTOPHONE

with the horns. As the cylinder rotates, its eight median apertures are brought successively opposite the air inlet of the jacket, and it is put into communication, successively, with the horns by means of its lateral openings, which are so arranged that no two horns are sounded simultaneously, and each horn is sounded twice in the course of a complete revolution.—La Nature.

Drawing Points of Waxed Charcoal.—Well-burned lime-tree-wood charcoal is cut into the form of the ordinary sticks, which must be laid in melted wax and left there about 15 to 20 minutes. Take them out, dry them between blotting paper, remove adhering wax and rub them off with flannel rags.

Disposition of Garbage in Various Cities

The Installations of Some European Communities

HAMBURG.*

IN THE northern and northwestern sections of the city of Hamburg garbage and house refuse are collected and carted to districts beyond the city boundaries to be spread over fields and eventually to be plowed under as fertilizing material. In the central, eastern, and southern boroughs, including the harbor, such material, after being collected, is incinerated in a municipal establishment commonly regarded as a model of its kind and one which has given perfect satisfaction during the entire fourteen years of its practical use. I am convinced that American municipalities can study profitably the experience of Hamburg in this very important matter.

The refuse reduced to ashes in the municipal plant is conveyed thereto in 4-wheeled water-tight iron carts, each of which has a capacity of about 4 cubic meters (141.3 cubic feet). The cart bodies can be lifted from the wheels by means of electrical traveling cranes and the contents discharged directly into the furnace. There are 36 of these furnaces, built according to the method of a firm in Leeds, England, all of which burn continuously, except when they require cleaning. When the fires are once started no commercial fuel is required and therefore the consumption of coal in the plant is insignificant.

The slag is removed from the furnaces in small iron carts and conveyed therein to a cooling apparatus where the contents are sprinkled with cold water, and thence to the slag breakers, which are capable of producing broken slag in three sizes in the following proportions: 16 per cent passing through a 5-millimeter mesh screen (0.197 inch); 50 per cent passing through a 25-millimeter (1-inch) mesh screen; 34 per cent passing through a 60-millimeter (2.36-inch) mesh screen. An electro-magnet is in operation in connection with the slag breakers, and it removes small pieces of iron, the larger pieces having been removed from the refuse before passing into the furnaces; or, if such are contained in the slag, they are thrown out of the rotary sieve drum at the lower end of the breaker.

The scrap iron recovered is sold at public auction, and the slag itself is disposed of at a fixed price of 23.8 cents per ton of 1,000 kilos (2,204.6 pounds). There is always a great demand for this slag, for which there are numerous applications. The fine cinders are used as a top dressing for promenades, the coarser grade for establishing the drainage foundation of roads, and the middle size for the top dressing of roads. Used in this way, garbage slag is cheaper than any substitute material, and it serves its purpose perfectly. It is used advantageously in mixing concrete, 5 parts of coarse slag, 1 part of cement, and 3 parts of sand being the ordinary proportions; or, 1 part of cement and 7 parts of middle-sized slag.

The very fine garbage slag may be utilized wherever coarse sand can be used; for example, to form a bed for street paving blocks, for the manufacture of slag bricks, as antislipping material on city streets in winter, and as filling material in buildings under floors and over ceilings. Many other uses could be named.

As a filling material between floors and ceilings, this slag is used very extensively in docks and warehouses of Hamburg, for the particular reason that it is absolutely sterile and, unlike other kinds of slag, contains no sulphur by which merchandise in storage is sometimes damaged.

The garbage incinerating furnaces furnish sufficient power to drive all the electrical machinery in the establishment to operate the cranes, slag breakers, and light plant, furnishing also electricity for the accumulators of an electric motor launch and an electric motor cart used in the transportation of garbage. At present only one motor cart is in use, and it is proposed to purchase a number of others, so that within a few years horses will be eliminated entirely in the handling of garbage.

Such city garbage as is not burned is utilized, frequently to fill up marshes and swamps, as well as for fertilizing purposes.

Contracts for the removal of garbage, whether for destruction by fire or for other disposition, are awarded by the government to private firms upon public tenders and in several lots, described according to the distances to be covered in transporting the refuse. Two firms for years have secured such contracts. These own the necessary horses and stables and rolling stock, and furnish the men; the carts in which refuse is conveyed to the incinerating plant are municipal property placed at the disposition of the contractors. Having very considerable outfits, the two firms seem also to control the transportation of sand, gravel, paving stones, and bricks within the city.

The present contracts for the removal of garbage were made in 1905 for a period of five years. The city pays $107 to $132, according to distance, per 1,000 inhabitants served. (The city of Hamburg has a population of 895,804.) New contracts were made this year with the same firms, according to which the contractors will receive $136 to $202 per 1,000 inhabitants; but these contracts are to run for two years only, for the reason that a second incinerating plant is in the course of construction and will be ready for use within that time.

The new destruction plant is being arranged much like the old one, except that the experience of fourteen years has been utilized, and instead of Horsfall furnaces the so-called "Hamburger öfen" will be employed. The new ovens are not unlike the Horsfall ovens, but are believed to have been improved upon to such an extent that whereas the Horsfall furnaces can dispose of only 9 tons of material per twenty-four hours, the new ovens will dispose of from 22 to 25 tons during the same period.

Householders in Hamburg are required to provide themselves with metal receptacles, which they place upon the curb line, usually twice a week, between 8 and 9 o'clock P. M. The garbage gatherers empty the cans into their carts between 9 P. M. and the early morning hours. The cans themselves are very seldom stolen, and it is possible, and indeed quite common, to purchase numbered cans from private firms which, if stolen, are replaced by the insuring firm.

The conditions in Hamburg are such that ordinary householders reduce the amount of garbage to be carted away as much as possible by destroying in kitchen stoves everything that can be burned.

LONDON.*

Acting on the request of American firms, special inquiries were directed to the engineers of several of the boroughs of metropolitan London for securing information regarding the collection and disposal of garbage. The substance of these replies is as follows:

In the borough of St. Pancras the collection of all garbage is supervised by officers in the direct employ of the borough council. The collection of house refuse is carried on by a staff in the direct employ of the local authority. The collection of street refuse is also made by the council's own staff, but its removal from the streets is effected by contractors. In the letting of contracts no distinction is made between individuals and corporations.

The borough is divided into eight wards for which separate bids are received, though sometimes more than one ward is given to a single contractor. The contracts are for twelve months on a lump-sum basis—that is, each bidder offers to remove the whole of the street refuse in any ward for a stated sum.

For the removal of house refuse, dust vans of 5 cubic yards capacity are employed, two men accompanying each van. Nearly all of the houses have portable dust bins, which are carried out by these men and emptied into the van. In a few cases there still remain fixed dust bins from which refuse has to be shoveled into baskets and carried to the dust van. The collection generally proceeds all day, from 7 A. M. to 5 P. M., but in certain main streets police regulations forbid dust vans to carry on their work after 10 A. M., and in these streets daily collection is made between 7 A. M. and 10 A. M., the residents being required to bring their dust receptacles to the footway.

In the case of hospitals, large hotels, and large restaurants daily collection is made, and in some of the more densely occupied localities the collection is made three times or twice a week, but generally throughout the borough the collection of house refuse is made once a week. No machinery is used in the disposal of the refuse. The larger part is burned, while the remaining part is sent away by canal barges. The street refuse becomes the property of the contractors who remove it, and it is disposed of as they can best arrange. It is nearly all sent away by barge on canal or river.

In the borough of St. Marylebone it has been the custom of the council to have house refuse collected and disposed of by contract. Bids are invited by public advertisement and the lowest bid is accepted, provided the council is fully satisfied, after inquiry, of the substantiality of the firm whose bid is proposed to be accepted. The council accepts the bid for one, two, or three years, as it considers best. The cost of the work during the fiscal year ended March 31st, 1910, was $51,930.

Horse-drawn carts and vans are used for the collection of garbage, and the receptacles for carrying the refuse from the premises to the vans have to be approved by the medical officer of health. Strong wicker baskets or metal receptacles are used for this purpose. The contractors collect the refuse during the whole of the day, except in special streets, where the occupiers are required to place the refuse on the curb in proper receptacles before 9 A. M. and the contractors are bound to remove it by 10 A. M.

The refuse is taken away by barge on the canal, and while the paper and garbage is burnt the siftings of the refuse are used for brick making.

In the borough of Islington the collection and disposal of garbarge is undertaken by a department of the council's staff under the control of the borough engineer. For this purpose the borough is divided into districts, each district, containing about 2,400 houses, being served by a gang consisting of four dust loaders (one of whom acts as "ganger"), three car men, and three vans. The several districts are divided into sections so that the houses of the several sections may be collected from on given days during the week, and the occupiers are thus aware of the day of the week when the cart or van may be expected. Householders as a rule are required to provide one or more movable receptacles constructed of metal of a capacity not exceeding two cubic feet each but sufficient to contain a week's accumulation of dust. The time of collection is from about 7:30 A. M. to about 5:30 P. M. daily. This system has been in force in this borough since 1895 and, upon the testimony of the town clerk, is said to work very satisfactorily.

The refuse from restaurants and eating houses, if likely to become a nuisance when allowed to accumulate, is collected two or three times weekly and in exceptional cases every day. Trade refuse, which is defined in the public health (London) act of 1891 as meaning "the refuse of any trade, manufacture, or business, or of any building material," is collected by special carts, the charge being 2d. (4 cents) per basket full.

The refuse, both house and trade, is carted to the council's depots adjoining certain railways passing through the borough and is tipped into railway trucks and conveyed to farmers and others along the line. The council pays a small sum toward the cost of the railway rates. The council has no dust destructors.

In the borough of Paddington the garbage of about nine-tenths of the area is collected by the borough council and the remaining one-tenth by contractors. The contracts are let to individuals for a period of three years for a lump sum per annum. The garbage is collected by horse-power covered tipping vans, usually between the hours of 6 A. M. and 6 P. M. The garbage is removed by barge along the canal by the contractors. The town clerk advises that machinery was abandoned several years ago.

The by-laws (ordinances) which govern the several borough councils are passed by the London county council, a body which has jurisdiction throughout metropolitan London, a copy of whose ordinances now in force for the public health is forwarded (and obtainable from the Bureau of Manufactures).

LIVERPOOL.*

The work of collection and disposal of refuse in Liverpool is done entirely by the corporation of the city, with direct employment of workmen and not by contract.

The total quantity of refuse collected per day in Liverpool is approximately 1,000 tons. Combustible refuse is collected and destroyed at the corporation's destructors, in the process of which steam is generated for various purposes. The clinker residue from this operation is utilized for the manufacture of concrete slabs and making concrete for foundations, bricks, mortar, etc. The refuse collected from the streets of a manurial nature is graded and sold for agricultural purposes, according to the quality. In this material is included the refuse from fruit markets, etc. Fish garbage is collected and disposed of for the manufacture of a patent fish manure. Old tins are separated and disposed of by being pressed by hydraulic machinery into billets and sold.

A separate class is made of waste paper, which is made up into bales and sold to paper manufacturers for repulp. Oyster shells are collected, and after grinding utilized as poultry gravel. Incombustible material and garbage of no value is conveyed to sea by steam hopper barge and tipped in deep water.

EDINBURGH.†

All refuse in Edinburgh is collected and disposed of by the municipal cleaning department. There is a daily removal system, the work of collection beginning every week day at 7 A. M. A city ordinance provides that "any straw, chaff, ashes, shop or house sweepings, or any offensive matter or thing" shall only be placed on a street or court "in pails, buckets, or other suitable vessels;" that waste paper "shall only

* From Consul-General Robert P. Skinner.

* From Consul-General John L. Griffiths.

* From Consul Horace Lee Washington.

† From Consul Rufus Fleming.

be placed on a street or court tied in a bundle, or after it has been reduced to pulp, and in the latter case the pulp must be contained in pails, buckets, or other suitable vessels;" that the time during which any of the above-specified material may be so placed on any street or court "shall be between 6:30 A. M. on any lawful day and the time at which the collecting cart may, on the same day, pass on its round;" that vessels placed on a street or court "must be removed therefrom within half an hour after their contents are emptied into the dust carts." The penalty for each contravention of this ordinance is a fine not exceeding £5 ($24.33) or in default of payment, imprisonment.

All kinds of garbage, ashes, etc., may be put out together in the same pail or box. Street sweepings are collected separately from other refuse, as is also stable manure.

The number of workers in the cleaning department is 581 men and 54 boys, who average about $6.10 and $3 per week, of 52½ hours, respectively. A week's vacation in the year with full pay is allowed. The total quantity of refuse (not including mud, sand, etc., from macadamized roads) dealt with in the year ended May 15th, 1909 (the latest period for which statistics are available), was 124,915 tons, of which farmers took 21,631 tons (street sweepings and stable manure) and a destructor consumed 15,416 tons, the bulk of garbage and other refuse being deposited near oil-shale mines 7½ miles from the city limits, to restore the level of the arable or pasture land.

The destructor, which takes the refuse from a small district, is simply a furnace, reducing everything to ashes or into the form of clinker, this latter residuum being sold to builders and others in small quantities, or, when no demand exists, dumped with the ashes into places in process of leveling up. Into such places are also dumped all the mud, sand, etc., from macadamized roads, amounting annually to about 60,000 tons.

The cleaning department received from farmers in the period mentioned $3,031 for street sweepings and $1,634 for stable manure, delivered by rail. On this material the railway freight alone was 16 cents per ton, and on the refuse taken to the oil-shale district the freight was 20 cents per ton. At the destructor the disposal cost was 63 cents per ton. Deducting revenues derived from the sale of manure, clinker, old tin cans, etc., and from special cleaning services at the city slaughterhouses and markets, amounting in all to $16,997, the net cost of cleaning the streets and of collecting and disposing of refuse was $244,051. The average net disposal cost rate for refuse, mud, sand, manure, etc., taken together, and totaling 184,930 tons, was 22 cents per ton.

There are some exhausted limestone quarries in the city's possession, bought for the purpose of depositing garbage and other refuse, on a tract of 115 acres called Burnhouse farm, 10½ miles from the municipal boundary. I am informed by the chairman of the cleaning and lighting committee of the town council that "in a short time the city will probably have these in use, and it is thought they will prove to be the best and cheapest method of disposal."

GLASGOW.*

The collection and disposal of garbage is under the direct supervision of the superintendent of the cleansing department of the corporation. The contract system, established in 1862, continued for six years, when the entire cleansing work was assumed by the city authorities. In the course of time privies and wet ash pits were abolished in favor of water-closets and dry ash pits. Power to close up all ash pits and replace them with portable galvanized bins was obtained under the building regulations act of 1900. In that year the change from ash pits to portable bins was commenced, and up to May 31, 1909, 11,906 pits have been abolished and replaced by 39,365 bins. Under the act property owners are required to abolish their ash pits; also to pay for the bins and their maintenance.

The refuse is now conveyed direct to a covered cart from the bin, thus avoiding the pollution of the atmosphere and the nuisance of light material being scattered by the wind. Refuse dispatch works and destruction furnaces were gradually erected for the disposal of refuse, and the unsightly and unsanitary gigantic heaps of accumulated filth in the open depots soon disappeared.

At the nine dispatch works the refuse is treated mechanically. The portions fit for sale as manure are separated from the lighter and unsalable parts, which are cremated in furnaces designed for the purpose. The process of treating the refuse at the works is briefly as follows:

Great quantities of soft sweepings require to be dealt with in wet, dirty weather. These sweepings are tipped into brick-built tanks, with sloping bottoms, fitted with perforated draining plates, so that in the course of a few days the material, which is chiefly composed of horse manure mixed with other refuse, becomes solid enough to be transferred to a railway car.

The domestic refuse is discharged from the carts through apertures in the floor into revolving screens fixed horizontally. A mixing machine beneath catches the finer parts of the refuse that pass through the screen.

Dry sweepings from paved streets are screened and mixed in a similar manner, and, from a tank above, a regulated quantity of excrementitious matter passes into the mixer, and when all is thoroughly blended it falls into a railway car on a siding below. The coarser parts of the refuse are forced from the screen, by the revolving process, onto an endless carrier, which drops them to a range of furnaces on a lower level. As the carrier passes on everything of value is picked off, such as scraps of iron, wire, bottles, glass, bones, rubber, tin cans, galvanized and enameled ware, etc. The corporation owns 700 railway cars, which they use for the conveyance of the city refuse over the various systems, and this process of separation is in operation at 4 stations.

The total quantity of material collected and disposed of by the department during the year ended May 31st, 1909, amounted to 358,972 tons 8½ hundredweight. The revenue derived from waste materials taken from city refuse and scrap from workshops and stores during the year ended May 31st, 1909, was: Clinker, $81,916; tins and galvanized buckets and light iron, $26,249; scrap iron, $38,675; waste paper, $32,694; bottles, $1,279—total, $180,813.

Prior to 1897 clinker was considered to be of no value and was trucked into the country, at a cost of 24 cents per ton. Introducing it to builders for concrete work resulted in creating a demand for clinker for that purpose. The revenue from clinker alone has grown from $1,200 in 1897 to $8,895 in 1909.

Old tins and galvanized and enamel articles, which in previous years gave great trouble and annoyance to the cleansing department, now produce a substantial revenue annually. All old tin articles are now detinned and the remaining steel is pressed into solid billets by hydraulic power.

At each station there is an inexpensive brick-built furnace for removing the tin and solder. The material is then conveyed in a motor vehicle to a hydraulic press and pumps at one of the stations, where it is pressed into billets. In the process of cremating the refuse more than sufficient power is generated to drive the clinker-crushing machinery and to furnish electricity for lighting the destructor stations, stables, and offices.

In 1900 the system of collecting waste paper by means of old bags issued to business premises and better-class dwelling houses was inaugurated. By this method the paper procured is clean, and consequently more valuable than that taken from dust bins, and to a great extent obviates the nuisance connected with its removal. The revenue from this source has grown in ten years from $580 to $3,200. This is a remarkable increase in view of the fact that private firms, paper-stock merchants, are competitors of the corporation.

In fifteen years the total revenue from the utilization of waste products has increased from $1,000 to $22,500. All domestic refuse and garbage from hotels, restaurants, etc., in the city are collected during the night concurrently with the street sweeping done by the sweeping machines. There are bins sunk in the pavement at regular intervals, in which are deposited the sweepings of the day staff. These bins are emptied nightly, and the contents, together with the sweepings left at the street side by the sweeping machines, are carted away.

Private streets and back courts, after being swept when required, are cleansed by use of 1½-inch hose attached to the street fire plugs. The court washings in the city average over 750 per day. The proprietors of these properties are assessed 2 cents per $4.86 of the annual rental to meet the expenses of this work.

After a heavy snowstorm, in order to avoid disorganization of the street traffic and great inconvenience to the public, the snow must be removed without delay; consequently at such times great activity prevails in the cleansing department. Salt is used to melt the snow on the tram tracks and is followed shortly afterward by the sweeping machine, which spreads the brine created by the action of the salt on the snow over the entire width of the street, thereby rendering it possible to clean the streets quickly. The snow and slush is then rapidly carted and tipped into the rivers Clyde and Kelvin or the most convenient of the various tips around the outskirts of the city.

In general, the cities and towns throughout Scotland have well-regulated cleansing departments, similar to that of Glasgow, with the exception that the smaller towns and villages have no furnaces for destructive purposes. Some consume their garbage at county furnaces and others are obliged to cart it into the country.

The city of Glasgow, with its population of over 870,000, is perhaps, all things considered, one of the best cleansed cities in the world. It has an excellent up-to-date sewerage system, an abundant supply of pure water, and its municipal government is of high order.

* From Consul J. N. McCann

A Four-Carbon Arc Lamp for Triphase Circuits

In 1904 Mercanton invented an arc lamp consisting of three specially devised and non-homogeneous carbons, connected severally with the three wires of a triphase circuit.

Bentireglio and Siciliani have studied three types of triphase arc lamps, regulated by two magnetic fields rotating in opposite directions.

Righi has recently invented a new type of triphase lamp, which produces a very constant and effectively distributed light, without the employment of complicated regulating devices. Three carbons, about 1/25 inch in diameter, are mounted vertically with their points up, so that they form the edges of a triangular prism, the base of which measures about 3/5 inch on each side. Each of these carbons is connected to one of the three wires of the triphase circuit. Above these three small carbons, a fourth carbon, about 1 inch in diameter, is suspended so that its axis coincides with that of the prism. As this arrangement allows the three lower carbons to make contact simultaneously with the upper carbon, it is easy to establish three arcs, arranged radially, and six craters. The greater part of the light of an arc lamp is emitted by the craters. In the Righi triphase lamp, owing to the position of the three upper and more important craters, most of the light is radiated downward, without the intervention of the reflectors which are required with monophase lamps.

The voltages supplied to the carbons can be diminished by impedances inserted in the circuits, or by transformers, with their secondary circuits connected as a $\triangle$ or as a Y. Although the construction of a regulator with two rotary fields presents no serious difficulty, Righi employs a simple hand regulator.

If three intermediate arcs are formed among the three lower carbons, with the central carbon raised high, and the central carbon is then lowered until three arcs are formed between it and the lower carbons, no great variation in the emission of light or the consumption of energy is observed during the movement. As soon as the three craters of the central carbon have been formed, however, the consumption of energy is usually diminished and the light, hitherto flickering and poorly distributed, becomes steady and is greatly intensified and distributed more effectively.

The central carbon is consumed very slowly and, in certain conditions, its craters are replaced by exceedingly bright protuberances which point toward the lower carbons.

The Mercanton triphase lamp can be operated with a frequency as low as 17 alternations per second, owing to the close approximation of its three craters and the fact that at least two arcs are always active. As the Righi lamp has six craters and produces a still greater concentration of heat, it can probably be operated with still lower frequencies. The importance of this point becomes evident when we recall that the minimum frequency that can be used with a monophase lamp is about 25, and that most triphase traction systems have a frequency of 15.

No very certain results have yet been obtained from attempts to operate the Righi lamps with the low-frequency rotor currents of an asynchronous triphase motor, as the frequency varies with the load and it is very difficult to keep it constant, but the inventor intends to resume the experiments as soon as more favorable conditions can be established.—Revue des Sciences.

The following note appears in a consular report for the year 1909 on the foreign trade of China: "In view of the almost limitless possibilities which seem to exist in China, especially in the great plains of the north, for the use of agricultural machinery, it is with reluctance that one has to record the opinion that under present conditions there is really no opening for its successful introduction. The financial risk attending the purchase of such machinery for the Chinese has been proved in several instances, and British firms in China have to be careful how they repeat similar experiments. Certainly British manufacturers desirous of introducing agricultural machinery into China would have to be prepared to share the risk with their agents to a much greater extent than they show any signs of doing at present. But the subdivision of farms among small peasant proprietors, who are extremely conservative in their methods, the cheapness of human labor and the absence of effective organization of agriculture on the part of the Chinese government, are among the conditions that discourage manufacturers from taking risks that experience has not justified."

The Paris Automobile Show*

The First Exhibition Held by the Manufacturers Themselves

SHORN of some of its former glory, and inaugurated under a new management, the Paris Salon of 1910, which closed on the 18th instant, was altogether a different Salon from the last, which was held two years ago. Nothing of the sort held in Paris could, in the nature of things, be anything but spectacular, and the present show is striking and in many respects characteristic. But the uniform system of decoration adopted had the effect of breaking up the vista of the Grand Palais, and in itself was more or less confusing.

The show itself was lacking in one of the features that, in the past, has rendered it the show of shows. In common with all shows of the day, but to a more notable degree, it lacked the element of extreme novelty, not to say freakishness, in cars, bodies and accessories. The rare imagination of the French was apparent in many instances, it is true, but not to its former extent. For the most part the exhibits were rather conventional in their nature, and sweeping trends were lacking. There were 350 stands, or less, 125 of which were occupied by exhibitors of cars. The accessory and components exhibits, which composed the remainder, for the most part were those of the established manufacturers and dealers who showed more or less standard wares. But two American makes of cars were in evidence, namely, the Mitchell and the Ford.

If the show may be said to have developed anything in the way of mechanical tendency, it is in the so-called "valveless" motor—which is not a valveless motor at all, but one having either sliding or rotary valves instead of those of the common or poppet type. There were practically a dozen different motors of this class to be seen, including one or two that were shown in the balconies and also including the Panhard, Mercedes and English Daimler cars, which are equipped with variations of the Knight engine.

Several of the engines which fall within the valveless classification appear to have been designed by followers of Knight, yet each of them has peculiarities all its own. For example in the Roland-Pilain, but one sliding sleeve is employed, instead of two, as in the Knight engine, the motor otherwise resembling the Knight in many respects. Incidentally it may be mentioned that the Roland-Pilain car, in which was mounted a six-cylinder motor of the type in question, was further distinguished by an equipment of hydraulic brakes which were applied to all four road wheels.

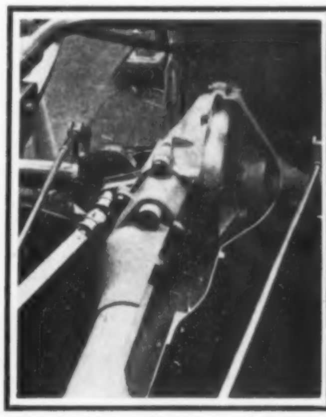
In the case of the motor shown by Mustad et Fils, the valve construction was equivalent to a single sleeve split in half vertically. Each half sleeve carrying a suitable port opening, as in the Knight engine, is actuated independently from one of two eccentric shafts. In the new Cottereau motor a single sleeve likewise is deemed sufficient, but instead of being made to travel up and down the cylinder bore, as is done in the case of the valve systems previously mentioned, the valve sleeve is merely caused to revolve in a suitable recess which is formed in the cylinder wall. The single port opening in its surface thus is made to register alternately with the inlet and exhaust openings. The Sizaire et Naudin, formerly distinguished as a light voiturette with a huge, single-cylinder motor, now is built in the form of a light and more conventional machine, and is equipped with a motor of the "valveless" type.

Among the engines which reveal more radical departures from precedent, perhaps none attracted more attention than the Henriod, partly, it is to be inferred, for the reason that its constructor in the past has distinguished himself by several unfettered flights of fancy in the way of novel design. In this case, however, there is nothing irrational about his achievement, which is, nevertheless, distinctly radical. It is, in brief, a form of rotary valve which is broadly suggestive of the Corliss steam engine gear. That is to say, the valve itself is a D-section, though revolving in circular bearings, the flat side of the "D" serving to uncover the single port in the cylinder wall and to open communication with the intake or exhaust at the proper instant of the cycle. Unlike the Corliss valve, however, it does not oscillate, but revolves. Hence by placing one of the passages above and the other below the valve chamber, the single member is made to serve both the inlet and the exhaust. A commendable point in the design is that the port is placed somewhat below the upper end of the piston travel in the cylinder, so that the valve is relieved of excessive pressure during the beginning of the firing stroke.

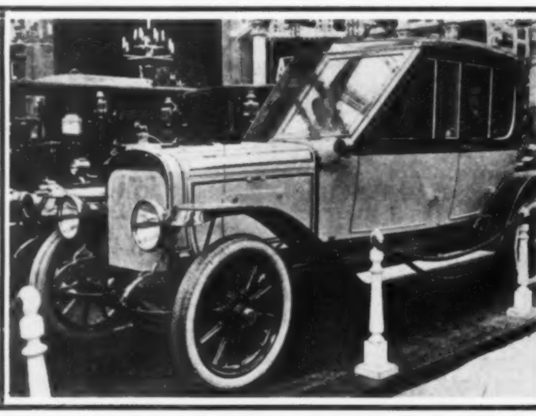
The Boissier motor likewise is furnished with a form of rotary valve, termed a distributor, in this instance, which is mounted above the cylinders and which, as it is carried in ball bearings, offers very little frictional resistance. Owing to the relatively large size of the distributor and its casing, the motor is given a curious and rather top-heavy appearance, which is not in the least relieved by the vertical motion shaft and the housing for the helical gears by which the distributor is actuated. Still another motor of the rotary valve type is the Ballo, in which the valves are of hemispherical formation and oscillate, instead of rotating. Their movement is brought about by cam action, the valve motion shaft and cams being inclosed in a housing above the cylinders, which is of peculiar and characteristic shape.

By all odds the most original, not to say freakish, design to be found was that of the Broc motor, in which the effects of a sliding valve and a rotary valve are achieved after a most curious fashion. The distribution is effected by the simple expedient of converting the piston itself into a valve and causing a portion of it to revolve in the cylinder in addition to its reciprocating motion. A helical groove is formed in the outer part which leads from the base to a point just below the head, where a hole is cored through to a couple of ports in the head proper. The intake and exhaust ports, of course, are located in the lower part of the cylinder.

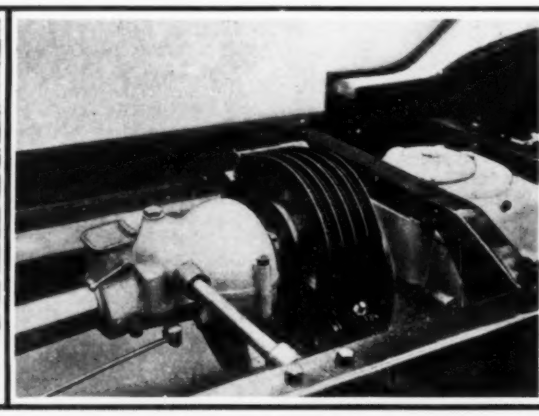
As a matter of fact, the piston is formed in two parts, the inner of which carries the true piston head, is connected to the crank shaft by means of the usual



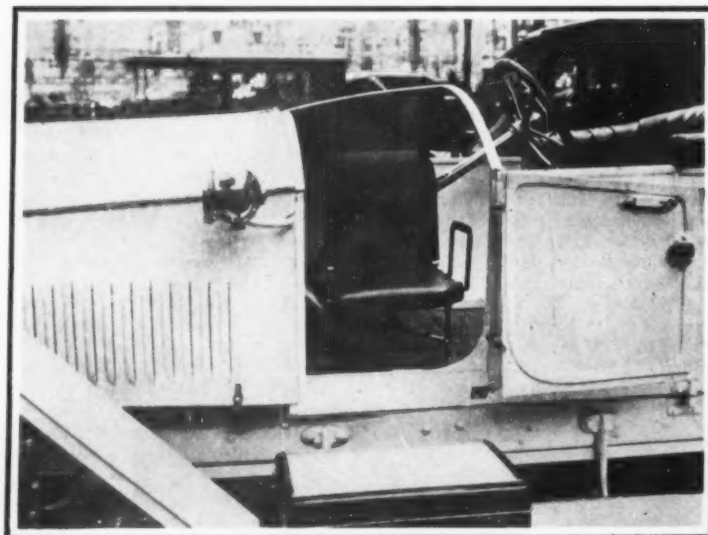
CUT-AWAY REAR AXLE AND DRIVE-SHAFT, SHOWING BEVEL-JOINT OF THE SIZAIRE AND NAUDIN CAR



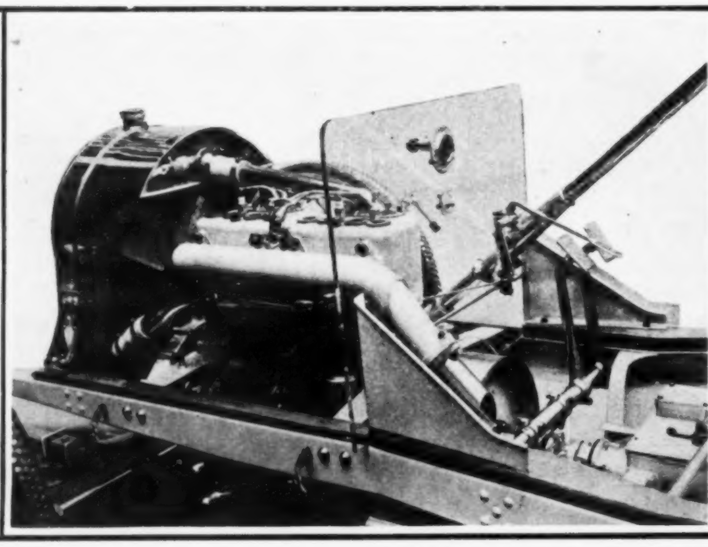
THE 120 HORSE-POWER PIPE CAR, WITH INCLINED WIND-BREAK, WHICH SHIELDS THE CHAUFFEUR AND CUTS DOWN WIND RESISTANCE



DETAIL OF BRAKE-DRUM AND CARDAN-JOINT OF THE RENAULT CAR



GOBRON CAR, WITH FOLDING SEAT



FOUR-CYLINDER 24-HORSE-POWER GREGOIRE MOTOR, WITH GLASS DASH

THE PARIS AUTOMOBILE SHOW

*Reprinted from the Motor World.

wrist pin and connecting rod, and does the work of driving. The secondary part is a surrounding sleeve, in which the helical groove is formed, and which is rotated by means of a bevel gear on the lower end of a tubular shaft which telescopes the connecting rod and is driven by a stationary bevel gear attached to one of the crank webs. As the piston reciprocates, the outer or valve portion is reciprocated with it and also is rotated to effect the distribution. Thus the motor is valveless only so long as the outer portion of the piston is by courtesy considered a part of this piston and not a valve.

Among other points observed at the show was the apparently growing inclination of the French builders, as well as those of other Continental countries, to construct cars well within what is broadly termed the medium-powered class. Particularly noteworthy at this time, indeed, are the numerous cars of 16 to 30 horse-power nominal rating, and especially those of somewhere about 20 horse-power. The block method of casting continues to grow in popularity, and not a few six-cylinder motors of relatively low power now are made in this fashion. Among such may be enumerated the Delage, which is rated at 16 horse-power, and has a bore and stroke of 66 by 12 millimeters, or roughly, 2⅝ by 5 inches; and the Delahaye, which is rated at 18 to 24 horse-power, and has its cylinders arranged in V form, in two groups of three, but all cast together, the cylinder dimensions being 75 by 120 millimeters, or 3 by 4 13/16 inches. Other small six-cylinder motors, but those in which the cylinders are cast in pairs or in blocks of three, are the 17 to 20 Mors, 16 Motobloc, 20 horse-power Darracq—a worm-driven model, it may be explained—15 horse-power Clement-Bayard, and 12 horse-power Delaunay-Belleville; the last has cylinder dimensions of 72 by 120 millimeters, or about 2¾ by 4 13/16 inches.

Two marked effects of the new style construction, which is expressed in the popular form of block motor, also are beginning to be apparent in other types as well. One is the desire to secure a "clean" engine by stowing away the auxiliaries as neatly as possible and relieving the exterior of the cylinders of any needless protuberances. The other is to extend the stroke. While abnormally long strokes by no means are the rule, they are also by no means uncommon, while the general tendency seems to be to increase the bore-to-stroke ratio.

Another observation was the periodical decline of the voiturette, which again appears to be passing into obscurity after a season of renewed popularity. The bulk of the European trade appears to be in cars of the medium class all through, and though closed cars continue to gain in popularity, the favorite styles are those in which the entire vehicle is inclosed, whether they afford accommodation for two or more passengers. The torpedo styles of touring car and runabout have come into vogue, and the influence of the torpedo is seen in many forms of closed cars.

A remarkable instance in point is that of a Gregoire car, which is built on thoroughly approved marine lines, with a ridiculously small body superstructure mounted in the center in close semblance to the conning tower of a submarine. Another remarkable achievement of the body-maker's art is the 120 horse-power Pipe, the front of which slopes from a point immediately above the driver's head to the dash, thus giving the machine the appearance of having just come through some dire catastrophe in which its front portion had been sadly crushed. A body which is far more appealing, if somewhat less striking in its appearance, is the Fiat "obus," which is a Rothschild creation, and which besides being of the most sumptuous order, is built with an eye to cleanliness and freedom from unnecessary windage.

The Gregoire "aviator" body is strictly a double coach, and has much the same effect as would be secured by mounting two sedan or coupe bodies on the same chassis. Needless to add, it is of the two-compartment type, as distinguished from many of the newer bodies, in which there is but a single door on either side and no dividing partition between the front and back seat spaces.

Among various individual body refinements may be mentioned one particular runabout body, mounted on a Gobron chassis, which is provided with a deep scuttle dash. Under ordinary circumstances there is nothing to indicate that the dash is in any way extraordinary. But when it is desired to carry a chauffeur, one side of the scuttle may be removed, disclosing a neat folding side seat into which a small or medium-sized chauffeur may be squeezed without serious inconvenience, and where he will be handy in case a tire goes down or the engine becomes obdurate.

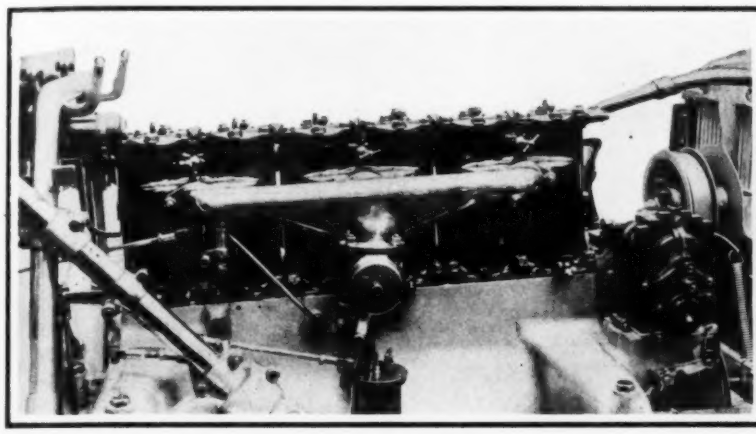
Ventilated dashes for the inclosed torpedo bodies, electric lights built into the dash or the front of the hood, after a fashion introduced by at least one maker in this country last year, separate spring suspension for the radiator and brass covers for the joints in the steering connections are novel and interesting details that were to be observed on various cars.

The general details of transmission and other chassis features reveal few striking changes in the new designs. Universal joint construction in many instances has been revised with the idea of obtaining better durability and freedom from wear, and in this connection the Isotta-Frashchini universal is particularly noteworthy. It consists of nothing more complicated than a disk of stiff leather which forms the sole connection between the flanges of the driving and driven members of the joint. Besides allowing perfect flexibility and small resistance, this device has the advantage of being absolutely noiseless.

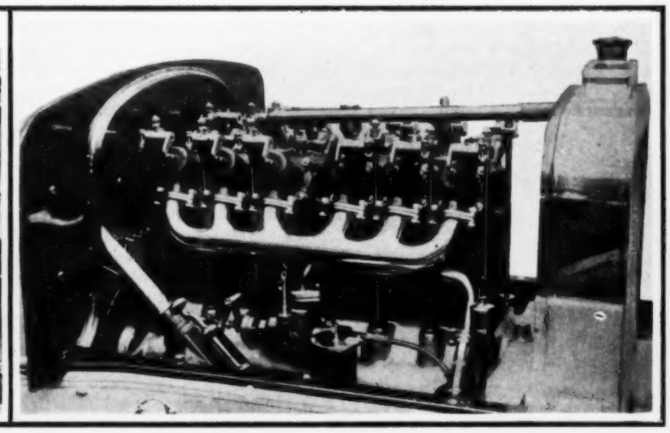
The new type universals on the latest Renault designs are housed in a neat aluminium casing. The rear springs of the new chassis shown at the Salon are of the three-quarter elliptical pattern, but with the lower or semi-elliptical members slung beneath the axle, thus affording a very low center of gravity. Three-quarter elliptic suspensions, by the way, are growing in popularity.

Shaft drive is employed almost exclusively, as is magneto ignition. Thermo-syphon cooling likewise is becoming exceedingly popular, while automatic self-contained engine oiling systems are the rule.

In addition to the Sizaire et Naudin change gear, which is of unique construction and mounted on the rear axle, one other peculiar axle-mounted change gear was in evidence—that of the Miolans car, in which the speed changes are effected by causing a single driving pinion to mesh with one or another of three sets of teeth on the large driven gear, the teeth, naturally, being of peculiar formation in order to render this combination possible. But one friction drive was in evidence, that of the Curicum, which employs the two-disk principle.

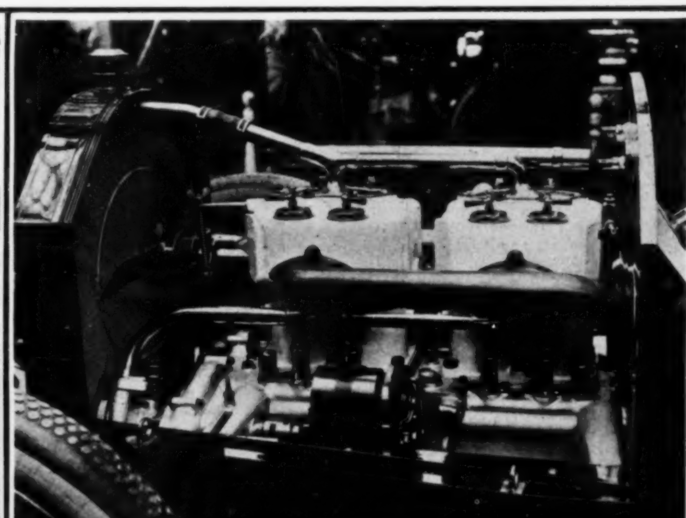


SIX-CYLINDER, 25 HORSE-POWER DAIMLER MOTOR



SIX-CYLINDER, 30 HORSE-POWER PIPE MOTOR

THE "FIAT" LIMOUSINE, WITH TORPEDO-SHAPED BODY



THE BENZ MOTOR FOUR-CYLINDER, 40 HORSE-POWER

THE PARIS AUTOMOBILE SHOW

Dentists Modeling Wax.—Twenty-five parts of pale gum copal are melted in the sand bath and when half cooled, 25 parts of stearine are stirred into it and dissolved. Then stir in 50 parts of Venetian chalk and 0.5 part of carmine, perfuming it with 2 drops of oil of roses.

The Development of Submarine Boats*

From Bushnell to Holland and Lake

By Simon Lake

WHEN the United States government in 1893 advertised for inventors to submit designs for the construction of a submarine torpedo boat, it is doubtful if a "corporal's guard" of officers in the United States service could have been found that had any faith in this type of vessel.

The submarine boat at that time was considered as great a curiosity by the majority of people as the flying machine was previous to the public flights of the Wright brothers a little more than a year ago. At that time neither the United States, England, Russia, nor any of the European countries were in possession of what might be termed a practical submarine vessel.

The French government had one experimental vessel in commission, called the "Gymnote," and another under construction, which was called the "Gustave Zede." The latter was launched in June, 1903. Both these vessels were of the diving type, and operated on the same principle as numerous others that had been experimented with during the nineteenth century.

The records show that nearly a hundred submarine boats have been projected or built to operate on practically the same principle as the "Gymnote," most of them vessels of small size. Drzwiecki, the inventor of the torpedo-firing apparatus which bears his name, built a large number of small vessels of this type for the Russian government in the seventies. They were one-man boats.

Several boats were built by the Confederates during the Civil War which operated on the same principle. The attempts to use these vessels, however, usually resulted disastrously, the boat having a tendency to dive head-first to the bottom, in some cases remaining there permanently, especially if the bottom was soft. If the bottom was hard and the hull was sufficiently strong to withstand the shock, the vessel would rebound to the surface.

Hovgaard, in his book on submarine navigation, refers to one of the early French boats of the diving type called "Le Plongeur." This boat was the most ambitious attempt to construct a submarine vessel during the nineteenth century. She was about 140 feet long, 20 feet broad, and 10 feet deep. Her beam was, therefore, twice her depth. She had an oval form in cross section and was presumably braced to resist the pressure of water when submerged. This form of hull would need to have been trongly braced to resist collapse at any considerable depth, as her plate was said to be only ½ inch near the keel and ⅜ inch throughout the rest of the vessel. She was propelled by a compressed-air engine which developed 80 horse-power when working with air at twelve atmospheres. It is stated that the engine always worked well. Her displacement was about 200 tons. In his description of this vessel Hovgaard says:

"The greatest difficulty was the regulation of the motion in a vertical sense. Operations commenced by closing all openings, and then water was let into the two air reservoirs, and into the water-tight compartments, until only the top of the conning tower was above the surface. It was found to be pretty easy to go like this, awash, along the surface of the sea. It was expected that the depth of immersion could be determined by small changes in displacement, namely, by using the piston in the regulating cylinder, but the experiment showed this to be quite impossible, and the vessel would often touch bottom, even in 30 feet depths, before the motion could be changed. When striking tolerably hard bottom, such as sand, the vessel would rebound like an India-rubber ball. Thus the 'Le Plongeur' would advance, striking alternately the bottom and remounting to the surface.

"The horizontal rudders and the regulating cylinders acted much too slowly. Most frequently they had to resort to the donkey pump or to air-pressure to expel water, but then the ascension would take place very violently, and when at the surface, the vessel would be found to have a buoyancy of several cubic meters. A vertical screw was therefore fitted to regulate the motion up and down; it was worked by hand. In this way the equilibrium under water was kept, but only for a very short time."

The result of the experiment was that it was possible to make a submarine boat slide along the bottom in the way described above, and also to move steadily awash.

It will be seen from the above description, and the abandonment of the vessel, that this boat, like many others of the type, was unmanageable when attempts were made to run her in a submerged condition. With her shallow depth and great beam it is probable that the failure of this vessel was largely due to a lack of longitudinal stability, which stability, in my estimation, is the first and most important thing in the designing of a suitable vessel.

The Confederates attempted to use the submarine boat during the Civil War and succeeded in sinking one of the United States warships. They called the little submarine boats which they constructed at that time "Davids," and the name was a most apt one. The next war will probably prove that the submarine "Davids" will be able, like David of biblical fame, to destroy the great "Dreadnaughts," or Goliaths, of the present day.

Previous to the beginning of the nineteenth century some experiments had been made in the construction of submarine vessels. The first important one of which there is any record was constructed in the seventeenth century by Cornelius Debrell, a Dutchman, who lived in England during the reign of James I. Nearly a hundred years later a man by the name of Day built a submarine and made a wager that he could descend to a depth of 100 yards and remain there twenty-four hours. He did, and according to latest advices, is still there.

The most authentic information at hand, however, regarding the early submarines, is of a boat built by a Connecticut man, Dr. David Bushnell, who lived in Saybrook during the Revolutionary War. He built a small submarine vessel called the "American Turtle," with which he expected to destroy the British fleet anchored off New York during its occupation by General Washington and the Continental Army.

"Thatcher's Military Journal" gives an account of an attempt to sink a British frigate, the "Eagle," of 64 guns, by attaching a torpedo to the bottom of the ship by means of a screw manipulated from the interior of this submarine boat. A sergeant who operated the "Turtle" succeeded in getting under the British vessel, but the screw which was to hold the torpedo in place came in contact with an iron strap, refused to enter, and the implement of destruction floated down stream, where its clockwork mechanism finally caused it to explode, throwing a column of water high in the air and creating consternation among the shipping in the harbor. Skippers were so badly frightened that they slipped their cables and went down to Sandy Hook. General Washington complimented Dr. Bushnell on having so nearly accomplished the destruction of the frigate.

If the performance of Bushnell's "Turtle" was such as described, it seems strange that our new government did not immediately take up his ideas and make an appropriation for further experiments in the same line. When the attack was made on the "Eagle," Dr. Bushnell's brother, who was to have manned the craft, was sick, and a sergeant who undertook the task was not sufficiently acquainted with the operation to succeed in attaching the torpedo to the bottom of the frigate. Had he succeeded, the "Eagle" would undoubtedly have been destroyed, and the event would have added the name of another hero to history and might have changed the entire method of naval warfare. Instead of Bushnell being encouraged in his plans, however, they were bitterly opposed by the naval authorities. His treatment was such as finally to compel him to leave the country, but he returned after some years of wandering, and under an assumed name, settled in Georgia, where he spent his remaining days practising his profession.

Robert Fulton, the man whose genius made steam navigation a success, was the next to turn his attention to submarine boats, and submarine warfare by submerged mines. A large part of his life was devoted to the solution of his problem. He went to France with his project and interested Napoleon Bonaparte, who became his patron and who was the means of securing sufficient funds to build a boat which was called the "Nautilus." With this vessel Fulton made numerous descents, and it is reported that he covered 500 yards in a submerged run of seven minutes.

In the spring of 1801 he took the "Nautilus" to Brest, and experimented with her for some time. He and three companions descended in the harbor to a depth of 25 feet and remained one hour, but he found the hull would not stand the pressure of a greater depth. They were in total darkness during the whole time, but afterward he fitted his craft with a glass window 1½ inches in diameter, through which he could see to count the minutes on his watch. He also discovered during his trials that the mariner's compass pointed equally as true under water as above it. His experiments led him to believe that he could build a submarine vessel with which he could swim under the surface, and destroy any man-of-war afloat. When he came before the French Admiralty, however, he was met with blunt refusal, one bluff old French admiral saying: "Thank God, France still fights her battles on the surface, not beneath it," a sentiment which apparently has changed since those days, as France now has a large fleet of submarines. After several years of unsuccessful efforts in France to get his plans adopted, Fulton finally went over to England and interested William Pitt, then chancellor, in his schemes. He built a boat there, and succeeded in attaching a torpedo beneath a condemned brig provided for the purpose, blowing her up in the presence of an immense throng. Pitt induced Fulton to sell his boat to the English government and not bring it to the attention of any other nation, thus recognizing the fact that if this type of vessel should be made entirely successful, England would lose her supremacy as the "Mistress of the Seas."

Fulton consented to do so, but would not pledge himself regarding his own country, stating that if his country should become engaged in war, no pledge could be given that would prevent him from offering his services in any way which would be for its benefit.

The English government paid him $75,000 for this concession. Fulton then returned to New York and built the "Clermont" and other steamboats, but did not entirely give up his ideas of submarine navigation, and at the time of his death was at work on plans for a much larger boat.

Fulton had a true conception of the result of submarine warfare, and in a letter he says: "Gunpowder has within the last three hundred years totally changed the art of war, and all my reflections have led me to believe that this application of it will, in a few years, put a stop to maritime wars, give that liberty on the seas which has been long and anxiously desired by every good man, and secure to Americans that liberty of commerce, tranquillity, and independence which will enable citizens to apply their mental and corporeal faculties to useful and humane pursuits, to the improvement of our country and the happiness of the whole people."

After Fulton's death spasmodic attempts were made by various inventors looking to the solving of the difficult problem, but no very serious efforts were put forth until the period of the Civil War, and then a number of submarine boats were built by the Confederates. These boats, as already referred to, were commonly called "Davids," and it was one of them that sank the United States steamship "Housatonic" in Charleston Harbor on the night of the 17th of February, 1864. This submarine vessel drowned four different crews, a total of thirty men, during her brief career. At the time she sank the "Housatonic" her attack was anticipated, and sharp lookout was kept at all times; but notwithstanding their vigilance she succeeded in getting sufficiently close to plant a torpedo on the end of a spar, and sink this fine, new ship of 1,400 tons displacement.

According to one of the officers of the "Housatonic," the attack was made in the following manner: "About 8:45 P. M. the officer of the deck, Acting Master M. K. Crosby, discovered something in the water about a hundred yards away coming directly toward the ship; the time from its appearance until it was close alongside being about two minutes, during which time the chain was slipped, engine backed, and all hands called to quarters. The torpedo struck the ship forward of the mizzen mast on the starboard side, in line with the magazine, and as we had the after pivot gun pivoted to port, we were unable to bring a shot to bear upon her. About one minute later she was close alongside and the explosion took place, the ship sinking stern first, and heeling to port as she sank. Most of the crew saved themselves by going into the rigging while a boat was dispatched to the 'Canandaigua.' The vessel came gallantly to our assistance and succeeded in rescuing all but a few of the officers. What became of the 'submarine boat' was a mystery not solved until a few years ago, when some divers in searching about the wreck of the sunken steamship found, a few feet away from her, the 'David' with skeletons of her crew still abroad. It was found that the hatch was open, and it is supposed that the water thown up by the torpedo caused her to founder with all hands."

It will be observed by the above description of the attack that the boat was not in a submerged condition at that time, but that her buoyancy was so reduced as to present a very small target. This enabled them

* Proceedings of the Engineers' Club of Philadelphia.

to maneuver the boat sufficiently near the "Housatonic" to prevent discovery until too late to ward off the attack.

The author was fortunate enough several years ago to receive a visit from Mr. Charles H. Hasker, of Richmond, Va., formerly lieutenant of the Confederate ironclad "Chicora," stationed in Charleston Harbor. While experiments were being made with the submarine vessel just described, Mr. Hasker volunteered as one of the crew for the experimental trip about the river, and was one of four that escaped when the vessel went down. He gave me the following account of her sinking:

"The submarine had a line fast to the steamer 'Etawan,' off Fort Johnson; the crew were all in their places, and had started the craft ahead. The buoyancy of the vessel had been reduced so that only the hatch combings were above the water. The side submerging vanes were operated by a tiller connected with the athwartship shaft, and were held in a horizontal position by means of a stick of wood placed beneath. When the vessel started ahead Lieut. Paine attempted to cast off the line which was made fast around the hatch combing. He became entangled in the line causing the boat to sheer slightly and careening her sufficiently to permit the water to come in the forward hatch. The lieutenant in his struggles to extricate himself, struck the prop which supported the ends of the tiller, thus causing it to drop to the floor and forcing the forward ends of the vane downward. This of course immediately pulled the bow of the boat under water." Mr. Hasker occupied the forward seat just at the hatchway. Lieut. Paine succeeded in getting out as soon as he saw the boat was going to sink, and Mr. Hasker grasped the edges of the hatch combing and finally forced his way through the column of inrushing water, which was, by this time, coming in with great force. But before he was entirely out of the opening the pressure of the water closed the hatch door, which caught his left leg below the knee. The pressure of the water was so great against the door that it crushed the muscles of the leg, and held him in this position until the vessel had reached the bottom in seven fathoms of water. The hull then being filled with water, equalized the pressure so that he was able to lift the door, and being an expert swimmer, he swam to the surface. The boat went down head-first, and before the after hatch got under water, two other men succeeded in escaping, the other five being drowned.

Notwithstanding that this was the third time the boat was sunk, she was again raised and a new crew was found to man her. Mr. Hasker states that he was unfortunate enough to be captured at the evacuation of Morris Island, about one week after this occurrence, was kept prisoner for fourteen months, and was at Hilton Head prison when he heard that the submarine had finally accomplished her mission in sinking the U. S. S. "Housatonic."

This brings us to 1893, and to the more recent attempts to solve the problem of submarine navigation, which at the present day is an accomplished fact, and every nation of importance is adding submarine torpedo boats to its fleet for purposes of defense, and many of them are even now proposing vessels for offensive as well as defensive purposes.

In 1877 Mr. John P. Holland built a small boat which was called the "Fenian Ram." It is stated that this vessel was built by capital furnished by the "Clan-na-Gaël," with the idea of using it against the British fleet in an attempt to free Ireland. It is reported that Mr. Holland, who was a school teacher, had been exiled from that country because of his political activity. From the published description of this boat it would appear to be very similar to the small boat turned out by Drzwiecki for the Russian government, in that it operated with a vertical and a horizontal rudder in the same manner as other boats of the diving type which have been mentioned.

Previous to the appropriations made in 1893, Mr. Holland had built several small boats of this type, and it is reported that he met with considerable success in navigating them.

Mr. Baker, of Chicago, had built a vessel of quite a different type. His boat was elliptical in shape and in form resembled the "Goubet" type of vessel. It was propelled by screws located about midship on either side of the vessel. These screws were operated by gear wheels in such a manner that the angle of thrust could be changed to submerge the boat; the vessel having a certain reserve of buoyancy, the propellers could be set at such an angle as to cause the vessel to submerge until she reached a given depth, and then, by slightly reducing the angle, the vessel would move forward theoretically on a straight course and on a line which would be a mean between the upward pull due to the buoyancy of the vessel and the downward and forward pull due to the inclination of the propellers.

It is reported that this vessel made a number of successful trials in the waters of Lake Michigan. The form adopted by Baker was one well adapted for giving great stability, but was not suited to speed. It was largely due to Baker's success, however, and to the report made by a board of officers which watched the performances of this craft in 1892 that the first appropriation of $200,000 was made for the construction of the United States submarine. When the appropriation was made, Baker was so sure of receiving the award for the contract that he moved from Chicago to Washington with the idea of being close to the government authorities while developing the plans for his large vessel. He died shortly after moving there. Mr. Holland, Mr. Baker, and the author, it is believed, were the only inventors of submarine craft that were present with plans in Washington at the opening of bids in June, 1893. The author did not submit a proposition to build a vessel, as the advertisement stated that the department would consider designs even if they were not accompanied by tenders for construction; and if the designs were considered meritorious, the department would itself arrange for the construction of the vessel. The author's designs were submitted to a board to pass upon their merits, and he was later advised by the late Admiral Matthews that his designs were looked upon with considerable favor by some of the members of the board at that time, but as the Holland designs were accompanied by a bid to construct, with a bond for performance, backed by a company, the Navy Department was reluctant to take upon itself the responsibility of the development of a vessel from designs only. The matter of awarding a contract was held in abeyance for over a year, and finally the award was made to the Holland Company for the construction of the "Plunger" on certain guarantees of performance, which guarantees were destined never to be fulfilled under the first contract, as this boat, the "Plunger," was to have done many things that even to this day have never been accomplished by any submarine boat. She was to have a speed of about 16 knots and be able to go from light condition to that of complete submergence in twenty seconds. Her construction extended over a period of several years, and she was finally abandoned in 1900, after the Holland Company had received additional appropriations and brought out a much simpler vessel in the "Holland," the first United States submarine torpedo boat which went into commission.

The first Lake design was of a submarine boat previously referred to, and was submitted to the United States Government in 1893, in response to a public advertisement asking inventors to submit bids for submarine boats for the United States Government.

Some of the features of this design were two hydroplanes on either side at the bow and the stern, with fore-and-aft rudders for correcting trim. There were wheels for navigating on the bottom. This boat was fitted with four torpedo tubes, two forward and two aft.

The "Holland" was the first United States submarine boat, and is the boat previously referred to, which took the place of the "Plunger," the first United States boat contracted for. This type of boat operates in the same manner as the early French and Spanish boats. It also operates on the same principle as the Whitehead torpedo, except that the intelligent control of man operates the vertical and horizontal rudders rather than automatic appliances. The principle of operation, however, is the same.

These boats are still built in the cigar-shaped form, which is, without doubt, the best form for under-water speed, but has certain disadvantages as a surface seagoing craft, and is more difficult to control when operating submerged. The earlier boats of the Holland type were lacking in stability and were very erratic as to their performance, having a tendency, as did the early boats of the same type constructed in France and Spain, and as did the boats of similar type before referred to that were constructed during the Civil War, either to run their nose into the bottom or to broach to the surface.

These vessels have been much improved however in the last three or four years, owing to the greater experience in their design and construction, and the necessity now—since competition has been permitted in the securing of submarine vessels for the United States navy—of providing vessels that will meet the requirements of the United States naval authorities. The standard of performance now required by the United States navy is the most severe of any country.

Early in 1901 the author received a request to come to Washington and submit designs to the navy department for the construction of submarine torpedo boats of the Lake type, as the department was not satisfied with the performance of its Holland type of submarine then. The designs of the "Protector" and of the cruiser type of boat were submitted to the Board on Naval Construction, at that time composed of five admirals, and the author was informed that his designs were considered superior to anything yet proposed in the way of submarine boats, either in this country or abroad. Congress had always specified Holland boats, notwithstanding the protest of many officers in the navy department. It was suggested however that if a submarine boat were constructed with private resources it was within the power of the navy department to see that such a vessel would be given a fair trial when completed, and that the department could make such recommendations as were impossible for Congress to ignore. On the strength of these promises the author started to construct the "Protector."

The later German Krupp boats are fitted with the buoyant superstructure and hydroplanes. The latest boats are fitted with omniscopes.

One of the features of the Lake type of boat has been that it carries its fuel outside of the living quarters of the crew, in especially designed tanks in the superstructure, which tanks are galvanized to prevent the escape of dangerous fluids or gases. Both the German boats and the Italian boats have adopted this feature, the only difference being that the fuel tanks were built up directly over the hull of the vessel rather than being built circular in form and galvanized after construction. It appears that the fuel leaked through this built-up tank in the Italian boat, "Foca," down into the hull, where it became ignited and caused an explosion which blew up the vessel and killed her crew of twenty-three men. This was probably due to some careless workmanship or neglect on the part of some members of the crew to take proper precautions in seeing that the pipe connections where they came through the hull were properly made. It is impossible to provide against the ignorance and carelessness of workmen and members of the crew. Many explosions have occurred, both in this country and abroad, on submarine boats, and numerous lives have been sacrificed which, with a little more thought and care, might have been saved.

There are a number of dangerous things in connection with submarine boats. The gas which is given off in large quantities from the batteries is hydrogen, and is very explosive. If the fumes of the gas are not pumped out as rapidly as they are given off, an explosion is very likely to occur. The fumes of gasoline when mixed with the proper proportion of air are also highly explosive. For this reason Lake boats always carry fuel outside of the main hull, and, fortunately, so far no lives have been lost on any of these boats, although a number of men were nearly lost last August on the Russian submarine "Dragon." This was before the boat was entirely completed, and was caused by the carelessness of one of the workmen in pouring several gallons of gasoline into the hull through an open pipe before the same was connected up. The accident resulted in severe injuries to a number of the men and about $100,000 damage to the boat.

The dangers of gasoline have brought about extensive experiments in trying to develop heavy oil engines for submarine boat service. Hundreds of thousands of dollars have been expended in trying to produce a satisfactory engine of this class. All governments are now calling for heavy oil engines, and if experiments now well advanced prove their practicability, it will bring about a revolution in the construction of internal combustion engines, not only for submarines, but for all other classes of boats using liquid fuel.

Two of the Lake boats, 161 feet long, are under construction for the United States Government at Newport News. One is the "Seal," the other is the "Tuna." The "Seal" is the largest and most powerful submarine boat now under construction for the United States Government.

(To be concluded.)

During the year 1909 electric lighting contracts were given out for new installations at Chungking, Chengtu, Changsha, Nanking, and Ningpo, and for more or less important extensions at Shanghai (settlements and native city), Hankow, Peking, Swatow, Moukden, and other places. Negotiations were going on at the beginning of 1910 for a large installation at Hangchow and for installations in several cities in Manchuria. Indeed, there may be said to be an electric lighting project in every city in China, although at Pakhoi the project is stated to have been abandoned in view of the successful introduction of incandescent mantles; the only difficulty is to find funds for carrying such projects into execution. Almost all contracts require to be financed by the contractors, and British firms, finding British manufacturers unwilling to supply plant, except for cash down, have sometimes co-operated with German firms, the latter arranging the finance in return for being allowed to participate. Thus several of the contracts mentioned above are for British engines and boilers and German dynamos. Payment is generally spread over a period of two or three years on proper security being given to the contractors.

Jarman's System of Electric Traction by Storage Batteries

A Pioneer Electric Tramcar

THE subject of electric traction by means of stored energy having come to the fore again, because of the improved form of storage battery by Mr. Thomas Edison, the following historical account of a storage battery system of electric traction that proved to be a thoroughly practical one from every test that could be made either from an electrical or engineering standpoint as well as from a constructional view, can but prove of value to many who are concerned with electric traction to-day.

It was on October 25th, 1886, that Mr. A. J. Jarman invited a large number of editors and proprietors of the daily and technical press to witness the practical working of a model electrically-propelled car at No. 443 Brixton Road, London, England. This model was fitted upon trestles at the back of the premises. A considerable number attended and saw for the first time an electrically-propelled vehicle.

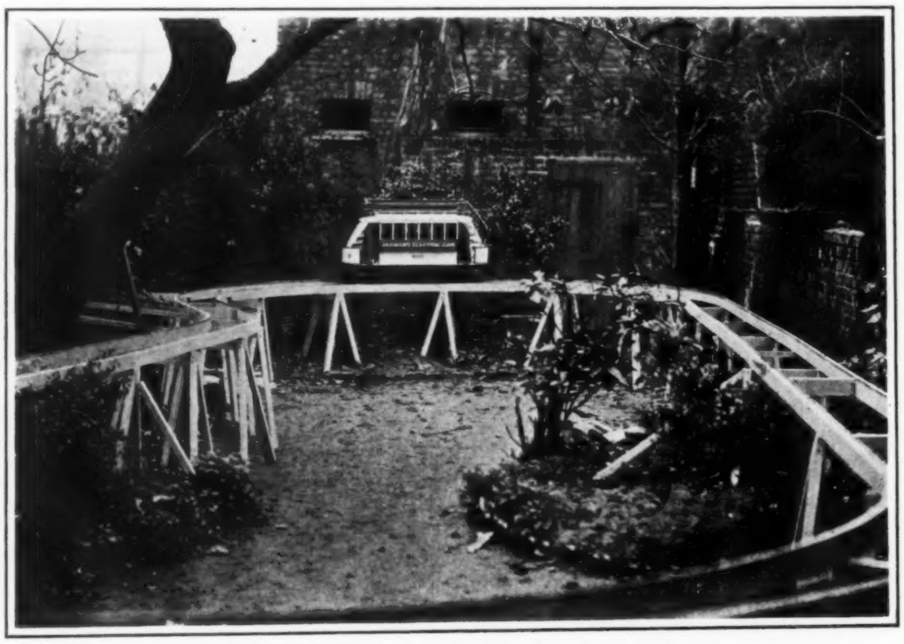
This model was 3 feet 7 inches long, was driven with a double armature motor and thirty carbon, zinc cells, placed beneath the seats. The car travelled at a speed of over five miles per hour. The tests lasted from 11 o'clock A. M. until 3:30 P. M., satisfying every suggestion made by the representatives of the press. One of the photographs shows the model and trestle tramway. Another photograph shows the experimental passenger car that was made from a disused horse car of the London Tramways Company. The car body alone weighed three (British) tons, equal to 6,720 pounds, the electrical equipment being in addition.

The inventor designed, built, and fitted a motor to this car with a double armature, which, when completed, was put on test by permission of the London Tramways Company after 12 midnight, when the horse cars ceased running. The trial took place in March, 1887, and the car ran from Atlantic Road, Brixton, to Westminster Bridge and returned successfully in every particular, carrying 45 passengers. At the end of the journey this car was driven over the macadamized Atlantic Road from Brixton Road to Electric Lane without rails by its own power. In November of the same year, the car was deposited at the disused stables of the London Tramways Company at Clapham Cross, where another trial took place. The car was driven from Clapham Cross to Blackfriars Bridge and return. (This was the first electrically-driven car that ran to the above bridges of the city of London.) Upon another occasion this car carried 115 passengers from Westminster Bridge to Clapham Cross.

The third photograph illustrates the car that was the outcome of every suggestion and improvement that the experimental car indicated. Fitted with reversible top seats, although constructed with seats for 44 passengers, it carried upon many occasions as high as 86 passengers.

This car was fitted with a compound bipolar motor of 14 horse-power, and compound gearing, together with ampere meters and voltmeters at both ends of the car, so as to enable the observer to note the actual electrical horse-power used, either upon a level or a variable incline. The construction of the motor differed materially from any hitherto attempted. The whole of the desired resistance was constructed within the windings of the field magnets, no external resistance being used whatever. The result was that only the necessary amount of electrical energy was employed to start the load without loss in a wasteful external resistance. By this plan the car could never start with a sudden jerk.

The following tests were made, that proved the value of this part of the invention. It may be mentioned here that the controller was so constructed that the forward and backward motion of the car was made by turning the handle to the right in four steps for forward, and to the left for backward motion, no extra controller being used, as is the case upon many cars to-day.

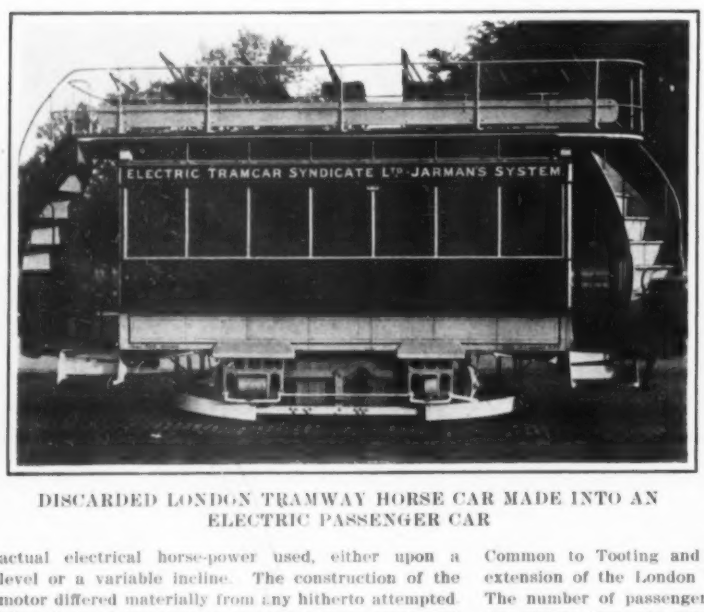


MODEL OF ELECTRIC CAR ON THE TRESTLE TRAMWAY

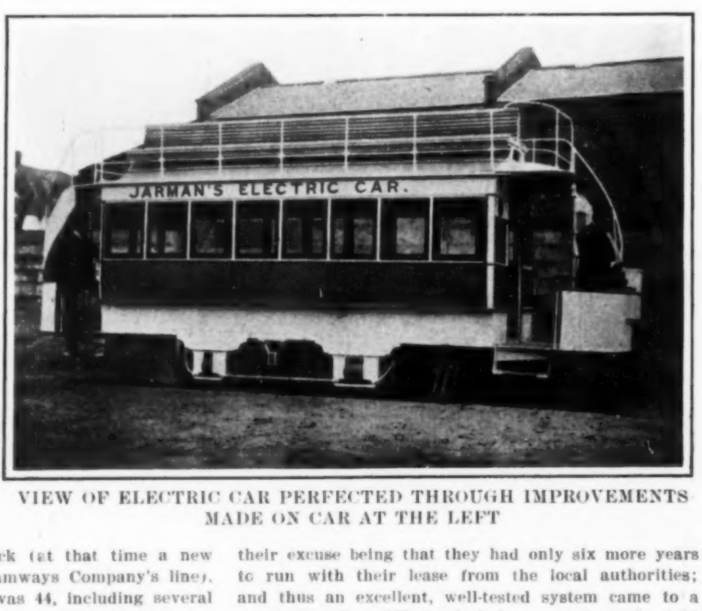
MOTOR TESTS.

Ninety storage traction cells were used, of the lead type, with aluminium fittings.

1. A current of 30 amperes was passed through the single motor and gave a torque or 60 pounds.
2. Fifty amperes was next put through the same motor, and gave a torque or 97 pounds.
3. The motor was coupled as the inventor had designed. All the windings being in series, a current of 28 amperes was passed through, which gave a torque of 117 pounds. The above tests were made many times over upon a Prony brake. These tests proved conclusively the economy in power production by this particular construction of motor. At the latter end of September, 1890, a thorough test of this car was made by making a run from Clapham Common to Tooting and back (at that time a new extension of the London Tramways Company's line). The number of passengers was 44, including several electricians from the Brush Electric Light Company and their chairman, the late Duke of Marlborough; the chairman of the London Tramways Company, D. P. Sellar, and all the directors, road surveyors, and engineers. The car was put to every test suggested, with complete success, with no hitch whatever. Balham Hill was ascended upon the return journey, which consists of a variable incline of 1 in 18 to 1 in 22, the current never exceeding 50 amperes, while as a further test this car pushed a horse car in front up the hill in addition to its load of 44 passengers. When running upon a level with wetted rails, 5 to 8 amperes was the only energy used, the speed being at the rate of ten miles per hour. An exact account of this run was given in the Electrical Review, London, October 3rd, 1890. This car could be run off the rails, put around a breakdown, and on to the rails again. Provision for this unusual work to be accomplished was made by the use of a pair of ramping irons, and a lateral movement of the front axle, the axle box being made specially for this purpose. The cost of working by this storage system has been well tested and proved during a period of eight years. When the time came for its general adoption upon the Clapham Tooting extension, as stipulated and in accordance with the written promise of the tramway company (under a guarantee of eight and a half cents per mile), the London Tramways Company backed out, and would not adopt it, although their premises had been leased to the Electric Tramcar Syndicate for twenty-one years, their excuse being that they had only six more years to run with their lease from the local authorities; and thus an excellent, well-tested system came to a standstill after $75,000 had been spent, and eight years of incessant labor. These storage-battery cars, like the Edison, had many advantageous points, especially when the American car bodies, made at that time by the John Stephenson Company of New



DISCARDED LONDON TRAMWAY HORSE CAR MADE INTO AN ELECTRIC PASSENGER CAR



VIEW OF ELECTRIC CAR PERFECTED THROUGH IMPROVEMENTS MADE ON CAR AT THE LEFT

work, were adopted. The electrical efficiency of the motor proved to be 94 per cent in all the workshop tests. Although two of these cars were thoroughly tested afterward in every-day traffic upon the Croydon Tramway Company's lines, running from Thornton Heath to Crown Hill, on time with the horse cars, the little syndicate was denuded of capital from the previous experience. Entirely through these difficulties the running of these cars ceased, although many meritorious parts of the invention are being adopted by others to-day in electric traction. The battery was lighter than any hitherto made, and of high efficiency.

Forms for Concrete

Schemes for Saving Time, Labor, and Lumber

SINCE freshly mixed concrete is a plastic material, forms of some kind are necessary to hold it in place and in shape until the cement sets up and the concrete becomes hard. Lumber, though expensive, is the material most commonly used. By exercising his natural ingenuity and customary care in the matter of construction of forms, the farmer has built so cheaply of concrete that his cost statements are frequently doubted by the builder in the city.

Much of the work done on the farm requires almost no forms at all. In this class are walks, floors in buildings, and feeding floors.

The first requisite of good forms is that they should be tight, so that the liquid cement may not run out between the cracks, cause pockets or hollows and thus ruin the looks of the work as well as decrease its strength. Consequently straight boards are most desirable unless one chooses to fill gaping cracks with stiff clay and tack strips over them. Dressed lumber is usually straightest and yields a neater finish to the concrete. But for ordinary purposes rough lumber is sufficiently good. Naturally the siding must be stiff enough not to bulge out of shape when the forms are first filled with concrete. This does not mean that very heavy siding is necessary. In fact 1-inch boards are usually sufficiently strong. The bulging may be prevented by setting 2 by 4-inch studding from 20 to 30 inches apart according to the thickness of siding boards or sheathing used.

The thoughtless cutting of boards into short lengths means a waste of lumber and a useless increase in the cost of concrete. Unnecessary nailing not only calls for more nails but adds to the difficulty of removing and the danger of splitting and ruining the boards. The reason that concrete is so unusually cheap for the farmer is that he plans his forms to spoil as little lumber as possible and he finds a use for all of the lumber after it has served to hold the concrete in place. In this way the material for forms costs practically nothing.

Most concrete work on the farm is built in what is known as the *box form*, which, with variations, consists of one box within another between which the concrete walls are molded. Such forms are used especially for walls of buildings, tanks, and troughs. Ordinarily the studding need not be cut in lengths equal to the height of the wall: it may without inconvenience be allowed to project above the top of the siding. Nor does it need to be sharpened (and later battered up at the other end) for driving into the ground. There is a quicker, easier, and cheaper way. Set the ends of the studding on the ground and hold them in their proper position by a timber, called a *liner*, lying on the ground against them; or "toe-nail" the ends of the studding to a plate which will serve the same purpose. Stakes driven into the ground and against the plates or liners will fix them firmly in place. The studding may be held plumb by bracing it with odds and ends running from the top to stakes driven into the ground a few feet away from the form. If the forms are so high and will be filled so rapidly as to render possible the springing of the studding, tie the opposite pieces together by means of bailing or other pliable wire passed through the joints in the siding. Space the forms at the top by means of cross cleats.

For the outside wall of box forms boards of full length need not be cut at all. The extra length may be allowed to extend beyond the corners. This saving cannot always be effected with the inner wall, yet odd pieces of boards may often be used in such a way as to prevent useless cutting. In nailing on the siding, arrange the boards so that all end joints will not be made on the same upright. If the lumber is crooked, draw the boards together so as to prevent cracks. Since the siding is generally between the studding and the concrete, heavy nailing is not needed to hold it in place until the concrete comes against it. Often cleats, clamps, or screws are used to save the lumber and to render easier the removal of the forms. The forms should always be planned with this end in view. In placing the concrete avoid unnecessary lifting by leaving off a few of the boards at the top of the form until they are needed. However, if chips or blocks fall inside the forms, carefully remove them before proceeding with the work.

See that the forms are lined up properly before beginning to fill them as they *must not* be disturbed after the concrete is in place.

If new forms are wet, before the concrete is placed, and allowed to remain in position until it has thoroughly set, bits of concrete will seldom stick to them. For very particular work, or where forms are to be used more than once, it is advisable to coat them, previous to erection, with soft soap or oil. Linseed, black, or cylinder oil is suitable, but kerosene is not good. Upon taking down the forms immediately clean off all bits of concrete clinging to them. For this purpose a short-handled hoe is convenient, but it must be used with care so as not to gouge the wood.

All other things being equal, the strength of concrete is dependent upon its density or compactness. Where possible, the easiest way to render concrete dense is by mixing and placing it wet. For very wet concrete the forms must be tight so that the liquid cement cannot escape. To give a neat finish to the surfaces, which will later be exposed, force the larger stones back from the outside by running a straight spade or a wooden paddle down in the concrete next to the wall forms and working it back and forth.

It frequently happens that very wet concrete cannot be used. To make a drier mix dense and strong, tamp or ram it into place with a heavy wooden or iron tamper.

In a way, the successful making of hay and concrete are very much alike—both must be well cured. Exposed surfaces of freshly placed concrete should be shaded to protect them from rain, dust, and the hot rays of the sun. Freezing injures freshly placed concrete. Hot water and salt are sometimes used to counteract the frost action; but, on the whole, it is better to attempt no outside work in winter. During the early months of spring and fall see that no frozen sand, gravel, or rock is used in the work. *In summer* ordinary forms, for walls supporting no loads, may be removed after the concrete is three days old, but *in cooler weather* they should not be touched short of five days.

It is the attention to the details which makes farming or any business a success. The same principle holds true of concrete work.

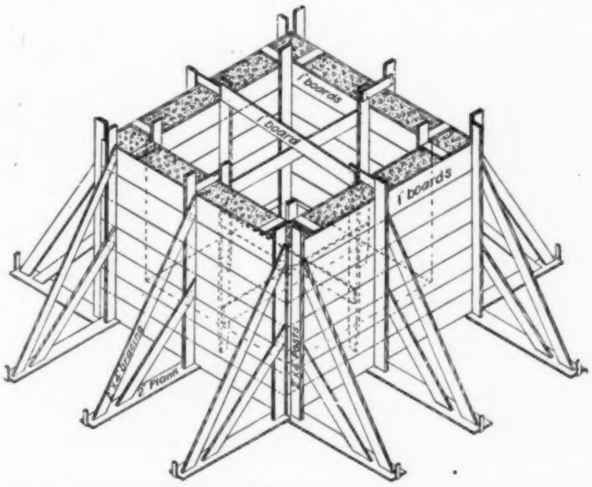
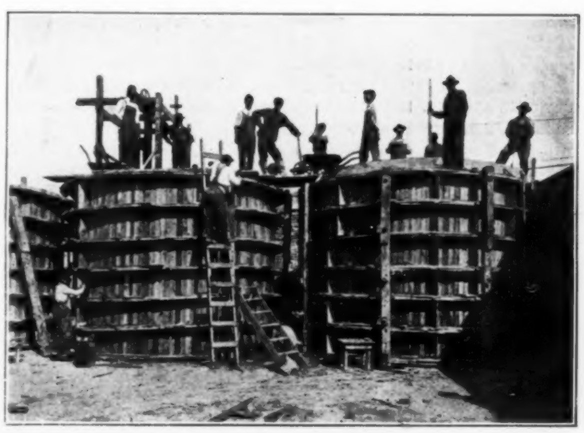
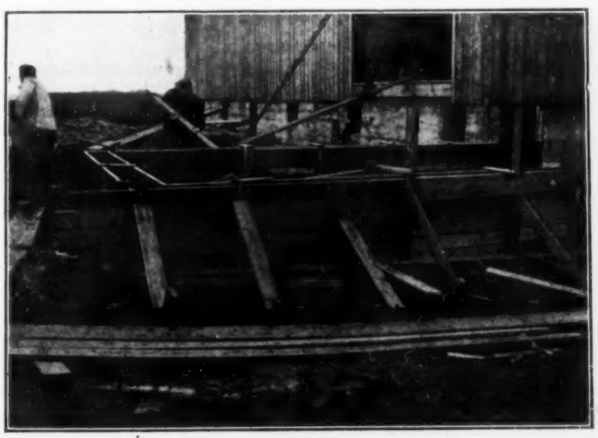


DIAGRAM SHOWING FORMS FILLED WITH CONCRETE


AN ILLUSTRATION SHOWING FORMS FOR ROUND CONCRETE TANKS


VIEW OF CONCRETE FORM WITH BOARDS PROJECTING BEYOND CORNER

The Turkish government has awarded the telephone contract for Constantinople to the Webb syndicate for the space of thirty years. The syndicate includes the Bell and other American interests. As regards the electric lighting contract for the European quarter and suburbs, the Sultan has ratified the decision awarding it to the Austro-Hungarian Ganz Company, backed by a strong syndicate composed of the Hungarian Bank along with French and Belgian capital. The contract figures at $4,000,000.

Balloon Signals*

An Important Aeronautic Consideration

Large airships have for some time been provided with wireless signaling apparatus, and small airships are now being similarly equipped. Spherical balloons, open below, can carry wireless receivers, but transmitting apparatus is excluded by its size and weight, and by the somewhat questionable danger of explosion. The usefulness of receiving apparatus alone hardly justifies its cost, for it includes a wire several hundred yards long, hanging from the car, and a double wire loop surrounding the gas bag or, preferably, a metal plating extending over an equatorial zone or the upper half of the bag.

An excellent but little used means of communication between balloons is afforded by luminous signals directed by a Morse code. The same method could be employed for communicating with the earth in many cases. A Nernst or other powerful incandescent electric light would be appropriate for a motorless balloon, and an electric arc, screened by wire gauze on the principle of the miner's safety lamp, would yield a brighter light for airships. The arc lamp could be operated by a small dynamo, driven by the airship motor. The incandescent lamp of the motorless balloon could be fed by Edison storage batteries suspended from the car in a bag and forming part of the ballast. For signaling to considerable distances, telescopes and parabolic mirrors or projecting lenses are required. The signals can be made by opening and closing a shutter.

The range of communication depends on the power of the lamp, and the size and quality of the mirrors, or lenses and telescopes. Great distances can be attained at night, and in daylight the range is at least equal to that of a Zeiss triple mirror of the same aperture. Theoretically the range is four times that of a triple mirror used with the same source of light, and equal to that of a triple mirror using a lamp sixteen times more powerful than the lamp employed with the system described above.

The Zeiss triple mirror is a device for sending signals by the reflection of light produced at the receiving station. It consists of a triangular pyramid of glass, in which the three faces that meet at the vertex are mutually perpendicular, like the three faces that meet at a corner of a cube. The light enters the pyramid through its fourth face, or base, through which it also emerges, after successive total reflections at the other three faces. This combination of three mutually perpendicular mirrors almost exactly reverses the course of a beam of light, even when the beam is not exactly normal to the base of the pyramid, i. e., when the triple mirror is aimed only approximately at the source of light.

By means of this device, an unlighted balloon can send messages to a station which emits a steady light, and, conversely, an unlighted station can give an immediate response to the inquiring flash of an airship's searchlight. In either case the Morse code can be used by covering and uncovering the triple mirror.

Variations in the position of the mirror do not affect the course of the reflected beam, unless these variations exceed the angular range within which a ray can be reflected from all three internal faces. A person looking into the triple mirror sees a reflected image of his face which remains motionless when the mirror is moved, turned, or oscillated, within its range of action. Hence it is easy to obtain and maintain communication with the receiving and light-giving station.

If the three reflecting surfaces are not quite perpendicular to each other, the triple mirror serves also as a telemeter. The effect of this construction is to divide the reflected light into two beams, which diverge very slightly from each other, and are seen at the receiving station to the right and left of the source of light, and separated from it by a distance proportional to the distance between the two stations.

If, for example, the ratio is 1 to 10,000 and it is found necessary to place the eye 12 inches to the right or left of the center of the lamp in order to see the flash of the triple mirror, the distance between the two stations is 10,000 feet. The range of signaling depends upon the intrinsic brightness (per unit of surface) of the source of light, and the aperture, or effective diameter, of the triple mirror.

The mirror here shown has a range, in average atmospheric conditions, of about 3 miles by day and 9 miles by night, when used with a Zeiss 10-inch signal lamp. These ranges can be doubled by employing an electric searchlight, having four times the brightness of the signal lamp.

The electric arc is the brightest of our artificial sources of light. With sunlight a range of at least 37 miles could be attained, but it would be necessary to throw the light upon the triple mirror by means of two very perfect plane mirrors, operated by two persons, as the motions of the sun and the balloon cannot be followed simultaneously with the simple army heliograph, in which the two mirrors are rigidly connected.

Without using sunlight, the range can be extended by increasing the size of the triple mirror. A 6-inch mirror would have a range of over 9 miles by day and nearly 28 miles at night. A solid glass pyramid of this size would, however, be inconveniently heavy. Hence the Zeiss firm has patented an arrangement of several triple mirrors, mounted on a board in square order and producing the effect of a single large triple mirror. Such an arrangement of four triple mirrors, of 4 inches aperture, would have a range of about 12 miles by day and 37 miles at night.

A great advantage of the method of signaling with the triple mirror is its absolute secrecy, for the messages cannot be received by any person except the observer standing beside the source of light. Yet any warship can throw its searchlight on a military balloon and receive secret information.

Communication with scouting airships many miles in advance must be carried on by wireless telegraphy. The secrecy of the messages can be assured only by an intricate cipher code, as the direction of the electric rays cannot yet be satisfactorily controlled. Even the system of Losi and Bellini gives merely a greater range in one direction than in others. Disturbance by other stations and the impossibility of identifying the sender of a message are additional defects of wireless telegraphy. The optical system is far superior within its limited range of 30 miles, and this range covers the most important military communications. The two systems should supplement each other.

In daylight, conversation can be carried on secretly, by the Morse code, between a station equipped with a searchlight and a balloon carrying a Zeiss triple mirror, for the beam of light cannot be traced in the air and neither the signals sent to the balloon by intermittance of the outgoing light nor those sent from the balloon with the mirror could be interpreted by an airship which might momentarily intercept the rays in its flight. At night, messages can still be sent secretly from the balloon, but the secrecy of messages sent in the opposite direction may be destroyed by the visibility of the searchlight's beams. (In clear weather the beam is not visible to a height much greater than 3,000 feet.)

There is, however, a possible method of sending secret messages over a visible beam of light. This method is called photophony, and it involves the employment of selenium cell and other receiving apparatus which, however, does not weigh as much as a large triple mirror. A few months ago the range attainable by this method, which was barely 5 miles, was greatly increased by the invention of the telephone relay by Brown, in England. It is claimed that the loudness of a telephone message is multiplied twenty-fold by the insertion of one telephone relay, and four hundred-fold by two relays. Hence it may be expected that a practical system of communicating over great distances by means of the photophone and the telephone relay will soon be developed.

* Abstract of a paper read by C. von Salviaté before the Aeronautical Congress in Dresden.

Celebrated Echoes

One of the most famous echoes is that heard from the suspension bridge across the Menai Strait, in Wales. The sound of a blow from a hammer on one of the main piers of the structure is returned in succession from each of the cross-beams that support the roadway and from the opposite pier at the distance of five hundred and seventy-six feet, in addition to which the sound is many times repeated between the water and the roadway at the rate of twenty-eight times in five seconds.

Outside the Shipley Church, in Sussex, England, is an echo that repeats twenty syllables in a most extraordinary manner. The famous echo at Woodstock, when awakened, answers no less than fifty times.

The whispering stone in Statuary Hall in the Capitol at Washington was possessed of a curious echo. A person speaking in a whisper near the stone would hear his words repeated from the extreme end of the hall. Reconstruction and rearrangement of the hall has changed all this to a great extent.

The echo in the castle of Simonett, about two miles from Milan, in Italy, repeats the report of a pistol fifty times, and in the Abbey Church at St. Albans, in England, the ticking of a watch may be heard from one end of the edifice to the other.

In the Cathedral of Girgenti, in Sicily, the slightest whisper is carried with perfect distinctness from the western door to the cornice behind the altar, a distance of two hundred and fifty feet. Curiously enough, at one time the confessional was so placed that the echo of the voices of those who were confessing could sometimes be overheard by the congregation. Later the confessional was removed to another part of the church.

In the whispering gallery of St. Paul's, in London, the faintest sound is faithfully conveyed from one side of the dome to the other, but cannot be heard at any intermediate point.

The Manfroni Palace at Venice possesses a square room about twenty-five feet in height. It is fitted with a concave roof. Standing in the center of the room, a person stamping softly on the floor hears the sound repeated a great many times, but as his position deviates from the center of the floor the reflected sounds grow fainter and fainter until they die out entirely. The same phenomenon occurs in the large room of the Museum at Naples.

In the Gloucester Cathedral in England a gallery of an octagonal form conveys a whisper seventy-five feet across the nave.

The Hollow Lake region of Ontario, in Canada, is fairly alive with echoes. On certain days a paddle dropped in the bottom of a canoe will sound as though several battleships were busily engaged in bombarding the place.

Can a Solid be Superheated?

It has never been found possible to superheat a solid, that is, to heat it above its melting point without melting it. Notwithstanding this negative result, some chemists, notably Ostwald, admit the possibility of superheating a solid, and attribute the failure to do so to defective conditions of experiment. A Swiss scientist, A. Berthoud, has lately taken up the question. He shows that Ostwald's conclusions, based on a false interpretation of some experiments of Frankenheim with hydrated sodium chloride, have no justification, and that Ostwald's opinion contradicts the theory, now generally admitted, which attributes retardation in change of state to the action of capillary forces.

According to this theory, if solidification, for example, does not take place, in the absence of germs, at the normal fusing point, this is because the very small solid particles which are first formed have a very large surface in proportion to their volume, and therefore possess a very great superficial energy. Hence their formation is associated with an increase of free energy and cannot take place in the absence of such increase. By adding to the supersaturated liquid a particle of the solid substance, the first phase of the transformation, which cannot take place spontaneously, is accomplished, and the solidification then goes on regularly. If this theory is admitted, it becomes necessary, in order to explain the impossibility of superheating a solid, to ascertain why capillary forces are not manifested in the act of fusion. The reason, according to Berthoud, is that the liquid resulting from the fusion wets the solid. Let us consider a piece of ice at the melting point. A drop of water placed upon the ice extends over the surface, so the boundary between ice and air is replaced by one between ice and water and one between water and air. This spontaneous phenomenon is associated with a diminution of the superficial energy, instead of an increase, so that the cause which in congelation, evaporation, etc., retards the change of state, to wit, an increase of superficial energy does not exist in the case of fusion. Hence, fusion necessarily takes place, without priming, as soon as the fusing point is attained. Superheating could only take place with a solid which is not wetted by its liquid.—Revue des Science.

The production of tin-plates and terne-plates in 1909 in the United States is estimated at 612,951 tons, as compared with 537,087 tons in 1908, an increase of 75,864 tons. Of the total in 1909, 527,714 tons were tin-plates, as compared with 468,297 tons in 1908, an increase of 59,417 tons, and 85,236 tons were terne-plates, as compared with 68,829 tons in 1908, an increase of 16,407 tons. In addition to tin and terne-plates, pure lead-coated and aluminium-coated steel sheets for special roofing purposes were produced in both 1908 and 1909 in small quantities. Of forty-five plants in 1909, eleven were not in use.

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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1850, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

Electrical Notes

Electric elevators for subways have not as yet been used on the Paris lines, but two of the new stations are now equipped with them. The stations lie on the part of the line which crosses the Seine near Notre Dame by means of a metallic caisson tunnel sunk from the surface. The two stations contained in the caisson work have been opened for service quite recently, and it is here that the elevators have been installed, owing to the number of staircases which need to be climbed. It will be some time, however, before the elevators are set running.

Among the large steam turbine plants in Europe may be mentioned the St. Denis station near Paris, and there are now ten turbines in use since the late increase. These are of the 100,000 size. A larger one of 16,500 horse-power has been added. All the turbines are coupled to dynamos. At the Milan station there are now four turbines of 8,000 horse-power and three others, making 42,000 horse-power in all. In Germany the Pleno-Westphalian Company is running two units of 10,000 horse-power and five of 8,000 horse-power. All these turbines are of the Brown-Boveri type, on the Parsons principle.

Much more light for a given power can be obtained from a mercury vapor lamp provided it is worked at a higher temperature than usual. However, the glass melts when we attempt to do this. On the continent a quartz mercury lamp is now made for the purpose, and it can be run at a high heat without danger of the quartz melting. The light is much better and approaches a yellow hue, and the glowing quartz adds red rays which improve the color. It is claimed that such a lamp is as economical as a flaming arc lamp, and therefore stands near the head of the list among all electric lamps. It has none of the objections which make the arc more expensive on a early run on account of renewing carbons and cleaning globes.

In a paper presented to the Academie des Sciences, M. E. Salmon describes his new researches for causing reactions between bodies in the electric arc. He uses an arc between tubular carbon electrodes so that the gas arrives by one tube and the products of the reaction are led off by the other. The apparatus consists of a quartz tube 8 inches long, closed at the ends by quartz stoppers having a 0.7-inch hole. The stoppers are luted on with plaster. Carbon tubes of 0.65 inch diameter are held in the stoppers by asbestos sheet so that they can be slid by hand to keep up the arc. The quartz tubes which are about 1½ inch diameter resist the heat of the arc very well. By this arrangement the gases must pass through the arc itself before leaving at the other side, which is best for the reactions. He first realized some already-known experiments such as combination of hydrogen and carbon to form acetylene, etc. The following results appear to be new. He secures the direct combination of nitrogen and carbon. Starting the arc for half an hour at first, he then passes a current of dry nitrogen through it. The resulting product was passed into a potash solution. As the solution was found to give a precipitate of Prussian blue with hydrochloric acid, this proved that cyanogen was formed by the arc and then absorbed by the potash to give cyanide and cyanate. The direct formation of cyanogen is thus to be noted. Second, it is known that copper does not decompose water when at furnace heat to any appreciable extent. However, the heat of the arc gives a decided result. Using an arc between a pair of copper tubes, he collected quite a measurable amount of hydrogen in a few minutes. Melted copper oxide was produced at the same time. Thus he produces a decomposition of water which cannot be realized at lower heats.

Science Notes

At Alise-St. Reine, France, Commandant Esperandieu discovered a small temple of hexagon form. It contained a pool which was fed by a spring, and this spring still exists here. No doubt the water was supposed to have healing qualities, seeing that votive offerings were found in the pool in the shape of images representing eyes and fingers, according to the custom. A number of marble busts were found on the spot. Seeing that the coins which came to light here stopped at the reign of Marcus Aurelius in the year 166 A. D., the edifice was no doubt destroyed at that date.

Dr. Cartier reports to the Academie des Inscriptions as to a recent find in the North African region near Souk-el-Arba. He uncovered a subterranean palace which was very well preserved. It is of the Roman period and contains intact vaulting, a Corinthian colonnade and several fine mosaics which have not as yet been all uncovered. One mosaic shows a female portrait of attractive appearance, while another has two Cupids mounted upon dolphins, with a framing composed of a fish design. He is continuing the work at present.

Tunisia produces a variety of fruits which may be divided into three classes. First, oranges, mandarines, and lemons; second, almonds and olives, and third, orchard fruits such as peach, apricot, pear, apple, etc. We also mention pomegranates and figs, which are cultivated rather by the natives than by Europeans. Most of the orange crop is sold in the country, and but little is exported. The almond and olive cultivation is on the increase, and new plantations have been made within the last ten years. Almonds are largely exported, and Tunisia produces 600,000 pounds of almonds yearly, exporting 400,000 pounds. The present exports of dried figs are 100,000 to 140,000 pounds.

M. Vournasos brings out a method for obtaining hydrogen arsenide gas by the action of formate of soda in the dry state upon arsenic and its compounds at a temperature of 400 deg. C. This method is not only applicable to the production of the gas, but it can also be used as well as the Marsh apparatus for toxicological research for arsenic. To prepare the gas, the author recommend using 3 parts of arsenic in powder or arsenite of soda and 8 parts of formate of soda.

Trade Notes and Formulæ

Washed clothes, bleached with chlorine (chloride of lime or bleaching powder) can with difficulty be freed from chlorine, even by repeated rinsing, and if put away holes are very likely to be eaten into them. If the washed linen, after rinsing, is passed through anti-chlorine, all the chlorine will be fixed and the linen will not be injured by the bleaching. Anti-chlorine is prepared by dissolving 1 part of hyposulphite of soda in 10 parts of water.

Water Colors.—Water colors prepared with gum or dextrine form hard, solid masses that can only be softened after prolonged rubbing with the moistened brush. To obtain water colors that will always be soft and can be readily taken up by the brush, a solution of sugar should be used, containing from 2 to 10 per cent of the weight of the sugar used of pure concentrated glycerine. As the latter constantly absorbs moisture from the atmosphere, colors prepared in the manner described never become perfectly hard. By using thick solutions of gum, to which glycerine has been added and with which the color has been rubbed down, we obtain water colors which can be put up for sale like oil colors in tin capsules (tubes) and are always ready for use.

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